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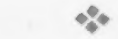

Inclined Roadway Hangers on a 470-Ft. Concrete Arch

Aerodynamics and the Civil Engineer—V

John F. Stevens Recalls Winter Railroading in Frontier Michigan

Modern Garbage Disposal Methods at Fresno, California

Constructing a new type of permeable groin, of precast concrete units, to protect one of Milwaukee County's parks from the destructive scouring action of Lake Michigan.

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Keep the Money at Work

LAST week this page pointed out one principle that should govern the spending of federal funds under the new work-relief program; i.e., that materials and equipment should be bought through normal channels. In the current monthly bulletin of the Cleveland Trust Company, Colonel Leonard P. Ayres sets forth another. He reminds us that the recovery effects of the federal expenditures will be materially reduced if the business men who eventually receive them as earnings use them merely to pay off their debts or to swell their bank accounts. He points out that such a course will stimulate little borrowing from banks and consequently little credit expansion.

> *"The lesson to be derived," he says, "is that the theory of stimulating business by increasing individual consumer purchasing power does not work out successfully so long as the funds expended by the government are mainly used by individuals to buy consumer goods. If the expenditure of public funds is to produce recovery, those funds must be used on a large scale by business men to purchase business goods, which are largely durable goods, as well as by individuals to purchase consumer goods. That takes place when business men have confidence in the future and believe that they see good prospects for profits through the expansion of operations and the modernization of equipment."*

THAT is precisely the reason why this page has urged so consistently that federal funds be expended through normal competitive business channels and that construction projects be prosecuted by normal methods. Thus only can we hope to stimulate confidence in future business and forward "the expansion of operations and the modernization of equipment." If we would thus expand business and multiply purchasing power it is evident that we should generate employment through existing business organizations and use modern methods rather than dole out public funds directly to individuals and boycott modern processes and equipment. Such a procedure could end only in a collapse of the public credit.

Of course, the payment of debts and the rebuilding of bank accounts are not altogether a dead loss on our recovery ledger. After all, the ratio of outstanding debt to current business volume still is one of the handicaps to recovery; moreover, the slender reserves in the hands of many business concerns do not foster that sense of security which is an important element of the all-essential confidence. If business now uses some of its earnings to pay off or reduce certain types of burdensome debt and to strengthen its reserves, it may for the moment soak up some of the governmental expenditure; but surely this will help to establish conditions more favorable to the confidence and expansion that Colonel Ayres so properly invokes as essential to substantial recovery.

But his major contention is sound: the current expenditure of public funds will achieve its maximum contribution to industrial recovery only when its every beneficiary employs the earnings from that expenditure to promote the continued expansion of industry as a whole. Hoarding, whether of cash or credit, means economic stagnation. The investment of such funds in modern plant and equipment is one means by which to keep them moving and to insure effective continuity of the priming process. Another is to apply them to aggressive and well-directed sales promotion, calculated to stimulate desire and demand for the products of the business itself.

THE productivity and ultimate success of the governmental expenditures thus will depend on two major factors. One is the degree to which government employs private business and normal methods in the spending process; another is the extent to which business keeps these funds at work, either through purchases from other producers or through promotional efforts that will stimulate demand and orders for its own products. Thus only can we help to generate the cycle of economic recovery.

Willard Chevalier

ENGINEERING NEWS-RECORD

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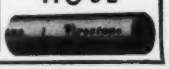

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In the News:

NEW YORK STATE has amended its engineer license law to restrict the practice of engineering by corporations. Corporations cannot be licensed to practice engineering, and such as are now practicing can continue to do so only if the chief executive officer or each member of a partnership is a licensed engineer.

NO DEFINITE WORD has come from the White House up to now as to when dirt will begin to fly on projects under the Relief Act. The President has indicated that it will take "a couple of months" to get ready. The act is to do its principal work during the twelve months from next July to the middle of 1936.

ALLOCATION OF RELIEF FUNDS is to be on the basis of unemployed on the relief rolls, not on a purely geographical or politically expedient basis, according to the best available information. Harry L. Hopkins is working on a list of unemployed now, and it is nearly ready but needs checking.

THOUGH RELIEF-ACT MONEY is tied up, Secretary Ickes still manages to find money for PWA loans and grants. The most recent allotment totals $8,460,000 and covers 85 non-federal projects, the largest being $600,000 to Lodi, Calif., for a combined hydro and diesel-engine power plant.

AN EARTHQUAKE in the island of Formosa is reported to have done wide damage and to have caused the loss of more than 3,000 lives. As providing new knowledge of earthquake effect on structure, this happening may be of little value because the island has few structures of engineering importance.

PROFESSOR S. TIMOSHENKO, in an address to the San Francisco section of the A.S.C.E. last week, urged tests on large specimens of parts subject to repeated stress. Stress concentrations produced at fillets, grooves and holes are smaller than their theoretical amount in the case of small specimens, but approach nearer to the theoretical value in large specimens; the effect of stress concentration also is usually larger for materials of greater strength, he said.

AN INDICATION that the importance of systematic stream gaging is being recognized appears in the Senate committee's action in increasing the stream-gaging appropriation to the U. S. Geological Survey by $150,000. The Interior Department bill as reported to the Senate carries $767,000 for this purpose, to be matched by the states.

SECRETARY OF INTERIOR HAROLD L. ICKES took a crack at the hand-labor fallacy in addressing the Associated Press at New York on April 22: "I do not propose going back to the hand loom or the foot-propelled spinning wheel, back to man-blown glass or hand-built carriages." He also said that quite aside from unemployment "the need of extensive public works to conserve and develop our natural resources, to prevent and correct soil erosion and recurring periods of droughts and floods, would demand our serious consideration. They are works which we cannot afford not to do."

LATEST UNEMPLOYMENT ESTIMATES show figures roughly identical with those of a year ago and a month ago. The National Industrial Conference Board estimates March unemployment at 9,760,000, which, is 125,000 lower than the February figure.

Down the Ohio River to Cincinnati—May 6-10

Whether or not you plan to ride a stern-wheeler down the Ohio to Cincinnati to attend the convention of the American Water Works Association, you should not miss the Water Works Number of *Engineering News-Record*, May 2. Ohio River water is used for other purposes than navigation or "to run under bridges," as that issue will tell you.

In This Issue:

EUROPE HAS PROVIDED the engineering world with many notable examples of pioneering in reinforced-concrete bridge design. Another such is described in this issue. In it a precast core for each arch rib was so used as to reduce greatly the amount of centering required.

HYDRAULIC ENGINEERS interested in eddies, vortices and the effect of turbulent flow in pipes and channels will find food for thought in the fifth article of the series on "Aerodynamics and the Civil Engineer."

FURTHER EVIDENCE of the aid that college research laboratories are giving to developments in the use of engineering materials is found in the notes on research work at Lehigh University.

ENGINEERS sometimes find facility in tree-climbing an asset: Read John F. Stevens' recollections of building the Duluth, South Shore and Atlantic Railway.

THAT THE SANITARY-FILL METHOD of garbage disposal can be carried out efficiently and without becoming a nuisance is evidenced by what is being accomplished at Fresno, Calif.

CHECKING OF BEACH EROSION is an engineering problem about which knowledge of the best methods is limited. A novel method has been tried successfully at Cudahy, Wis.

NEW for OLD *with the help of* STUCCO

HERE'S one time the doctor took his own medicine—and liked it.

J. S. Schirm Commercial Co. has sold building materials in San Diego for many years. Those years took toll on warehouse and office buildings. In fact, though still structurally sound, they began to look pretty shabby. "We'll not only *tell* our customers about modernizing," decided the Schirm people, "—we'll *show* them."

The pictures show the job that was done—and what a job it is! The gleaming new modern exterior is pure white Mission stucco, a prepared stucco made with Atlas White portland cement. Placed on the sturdy walls of the existing structures, it worked an economical miracle. The Schirm buildings are now one of the best sales arguments for modernizing that the Schirm people have.

On the walls of any structure, new or old, Atlas White stucco (a *factory-prepared* stucco is preferable) provides a durable, firesafe finish, economical to apply and to maintain. It is made in any color, is applied in any texture and is suitable to any architectural design. For details write Universal Atlas Cement Co. (*United States Steel Corporation Subsidiary*), 208 South La Salle Street, Chicago.

***At top*—This is the way the office and warehouse building of the J. S. Schirm Commercial Co., San Diego, looks today, after remodeling with Mission stucco made with Atlas White. Herman Louis Bodner was the architect. Clark and Scholbraid were plastering contractors. Both of San Diego.**

***Directly above*—The same building before remodeling.**

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STUCCO *made with* ATLAS WHITE PORTLAND CEMENT

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April 25, 1935

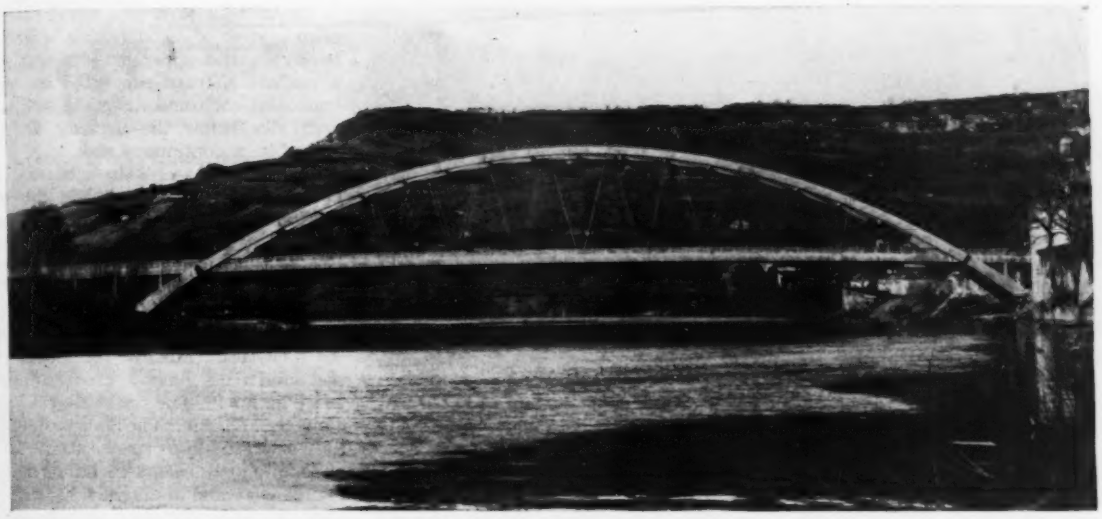


FIG. 1—HIGHWAY BRIDGE at Castelmoron in France whose make-up includes such unusual features as inclined hangers, precast rib cores and swaybracing and three hinges, one each at the intersections of the deck with the ribs and the other at one abutment. The span of 470 ft., though long for a through concrete arch, is now exceeded by that of a new bridge over the Seine at Roche-Guyon, which is 528 ft. long.

Inclined Hangers Impart Slenderness to Ribs of 470-Ft. Concrete Arch

French bridge utilizes a unique design claimed to eliminate bending stresses in the arch ribs—Ingenious construction plan using precast rib cores and precast bracing in combination with crown jacks permits centering to be built for only one-half the dead load of ribs

By A. E. Bretting
Chief Engineer, Christiani & Nielsen, Copenhagen, Denmark

A NEW highway bridge over the Lot River (a tributary of the Garonne) located at the town of Castelmoron in southern France and completed at the end of 1933, embodies features both of design and construction that may be of interest to American engineers. A reinforced-concrete through-arch bridge of 470-ft. span, it is designed as a three-hinged unsymmetrical arch, and, by virtue of several unique features, the heavy appearance that often characterizes bridges of this type has been entirely avoided. Principal among these are the use of inclined hangers, which reduce the bending moments in the ribs and thereby permit more slender members. These ribs are made up of a precast core prestressed by jacks at the crown before the outer envelope or major portion of the rib is poured. This expedient gives a better distribution of stress over the rib cross-section and also permits a saving in falsework costs, since the centering had to be designed to carry only about one-half the dead load of the arch ribs at one time. The relatively heavy members of the swaybracing system were also precast.

Design

The bridge, providing an 18-ft. reinforced-concrete roadway and two 3-ft. 3-in. sidewalks (Fig. 3) was designed for a uniform live load of 102.4 lb. per sq.ft., or alternatively for four trucks of 16 tons each. Wind pressure acting on the unloaded bridge was taken as 51.2 lb. per sq.ft. Of the three hinges in the ribs, two are located at deck level, and the third is at the right-hand abutment (Fig. 4). The principal system thus being statically determinate, no stresses are introduced in the structure by settlement of the foundations or by a uniform variation of the temperature of the bridge. In addition, the horizontal component of the thrust at the right-hand abutment almost entirely compensates the tension in the bridge decking between the two upper hinges. This portion of the decking is suspended from the arch ribs by means of inclined steel rod hangers in accordance with a patented system invented by Dr. O. F. Nielsen. By adopting this system the bending moments in the arch ribs between the two upper hinges are reduced to such an extent that their influence on the dimensions of the ribs is almost

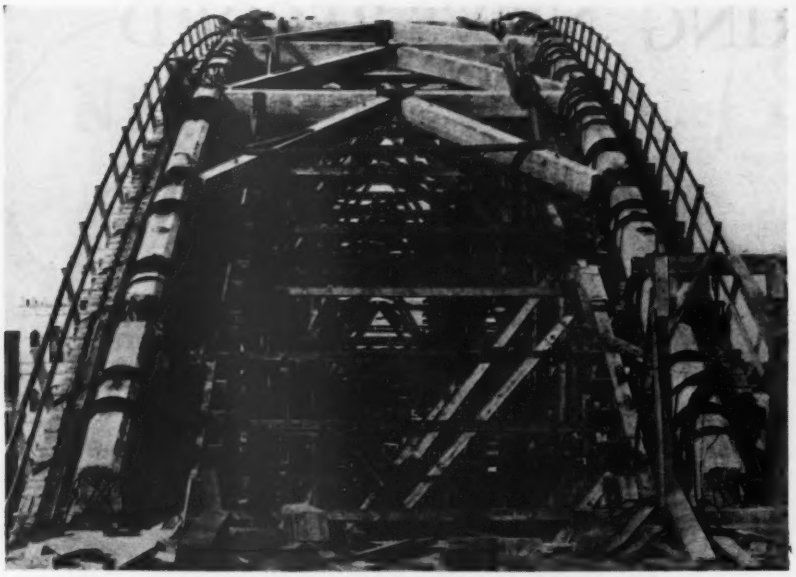


FIG. 2—PRECAST CONCRETE MEMBERS, which after joint concreting were lifted clear of the centering by hydraulic jacks at the crown of the ribs, to form a slender precast arch of 470-ft. span. A heavily reinforced envelope, spirals for which are shown, was then cast around the rib cores, completing the arch.

FIG. 3—ROADWAY VIEW of Castelmoron Bridge over Lot River in France.

negligible, and the arch-rib section is therefore very largely governed by the normal thrusts only. A very considerable reduction of the dimensions of the ribs is thus made possible.

It is perhaps surprising that a relatively slight inclination of the hangers can cause a considerable reduction of the bending moments in the arch ribs. In Fig. 5 is shown a statically determinate system corresponding to the one employed in the calculations. The connections between the tie and the lower ends of the oppositely inclined hangers are loosened and replaced by imaginary sliding devices. This system is subjected to a dead-load G acting at each of the lower panel points. If, now, one of these panel points is subjected to a live load P, the arch will deflect approximately as indicated. The slides will move horizontally in relation to the tie, and the bending moments in the arch will be approximately the same as in the case of vertical hangers.

It is to be noted, however, that the basis system subjected to the loads G and P can be made identical with the actual system by forcing the slides back to their original positions on the tie by means of pairs of horizontal forces x, acting at the panel points. It is evident that these forces will produce bending moments in the arch of opposite sign to those produced by the load P and will further introduce stresses in the different parts of the tie. It is assumed that the tie is intersected at the center of the span, so that the stress in the tie is found by adding up the x forces between the central joint and the point in question.

The horizontal component x at the panel point will be proportionate to the horizontal displacement of the slide, as long as both hangers from the panel point in question are in tension. When the tension in one of the hangers is reduced to zero, the reducing moment has reached its maximum. In actual practice, however, no hanger will ever be without tension in it.

While the maximum bending moment in an ordinary arch due to live load generally amounts to about $1/50\ pl^2$, where l is the span and p the live load per meter, the maximum bending moment in an arch with inclined hangers is, under the same conditions, only about $1/500\ pl^2$, and the deflections of the structure will of course be correspondingly smaller.

The slender arch ribs require an efficient system of windbracing which, between the two upper hinges, consists of a normal K-truss supported on portal frames at each end (Fig. 3), while the arch ribs below the decking are connected by a continuous slab.

The arch ribs contain a central core precast on the ground, while the outer portion was concreted in place. An average section of the arch rib is shown in Fig. 6. The cross-section of the ribs at the crown is 3 ft. 11 in. high and 3 ft. 3 in. wide, increasing to 4 ft. 11 in. x 3 ft. 2 in. at deck level and 7 ft. 3 in. x 7 ft. 3 in. at the skewback. Most of the members in the wind truss have a cross-section of 1 ft. 8 in. x 1 ft. The steel hangers have a diameter of 3⅛ in. The floor system consists of cross-beams spaced 32 ft. 10 in., of longitudinal beams at either side of the roadway and of diagonal beams. No joint occurs in the decking between the two upper hinges.

The maximum compressive stress in the arch-rib concrete was fixed at 1,138 lb. per sq.in. The arch cores, however, were stressed considerably higher, to about 1,920 lb. per sq.in., for which reason heavy spiral reinforcement was used in the exterior section of the arch ribs.

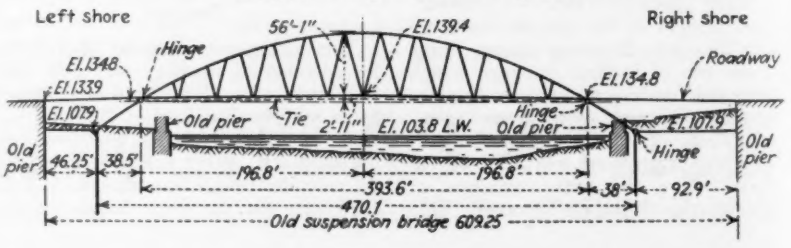
A high-grade cement was used for the concrete in the arch ribs, in an amount of 400 kg. per cubic meter of finished concrete. The mix was about 1:1.5:2.5. The same cement was used for the windbracing but only in an amount of 350 kg. per cubic meter.

For the remaining portions of the work ordinary portland cement was used. The concrete in the decking contains 300 kg. of cement per cubic meter (about 1:2½:3½ mix), and the concrete in the abutments contains 250 kg. (about 1:3:5 mix).

Construction procedure

The falsework for the arch span consisted of a light timber structure, and the sequence of the various construction operations was such that the maximum load on the centering never ex-

FIG. 4—DIMENSIONS of three-hinged unsymmetrical concrete arch, which replaced an old suspension bridge on the same alignment.



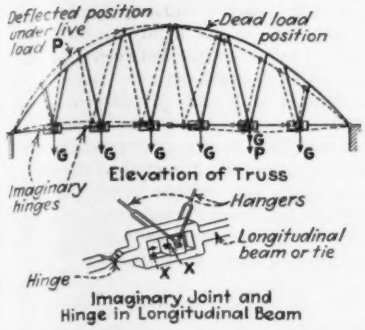


FIG. 5—DESIGN SKETCHES illustrating how action of inclined hangers reduces live-load bending moments in the arch ribs.

ceeded about one-half the dead load of the arch ribs themselves. This centering was framed and fitted together on level ground near the site of the bridge, during the time that concreting of the core pieces of the arch ribs was being done. These core pieces had steel flats embedded at the ends, the idea being to bolt the individual pieces together after their placing on the centering and thus to safeguard their correct relative positions. To avoid difficulties due to difference in shrinkage of the concrete in the core and in the exterior part of the rib section, the core pieces were stored under moist sand so as to postpone the shrinkage. The precast pieces of the windbracing were also concreted at this stage to be in readiness for placing on the centering. A rolled steel joist was embedded in each vertical of the K-truss, to allow the concrete to be omitted on a short length at the middle, so as to make room for the projecting reinforcement of the diagonal pieces when placed in position.

Erection then began, both arch cores and windbracing members being transported to place by means of special buggies hauled on tracks following the curvature of the arch (Fig. 7, right). The individual core pieces were placed in their predetermined positions on small concrete blocks corresponding to the thickness of the cast-in-place portion of the arch rib, and were thereafter bolted together as indicated in Fig. 2. The concrete blocks transmitted the weight of the core pieces to the centering in such manner that the arch core could slide in relation to the centering when subjected to pressure from the jacks.

All precast members being placed in position on the centering, the panel points along each arch core were cast, while temporary connections only were arranged between verticals and diagonals in the K-truss bracing. A slender arch, consisting of core pieces and bracing, was thus formed.

The next operation was to place four 150-ton hydraulic jacks (Fig. 8) in a joint left at the crown of each arch and, by means of these, to introduce in each rib a thrust of about 200 tons, which had the effect of relieving the centering of the superimposed load. The shortening of the arch cores due to this pressure was found to correspond to a modulus of elasticity of the concrete of about 4,700,000 lb. per sq.in.

The panel points at the middle of the verticals in the K-truss were now concreted, and most of the secondary stresses in the windbracing due to the shortening of the arch ribs was thus eliminated.

The inclined hangers were next placed in position and fixed at their ends to a tie extending between the two upper hinges in such manner that the strain in two adjoining hangers could be adjusted. This was followed by installation of the reinforcement in the external portion of the arch ribs and, after the erection of the necessary forms, the concreting took place, the weight of this concrete being carried by the centering.

When the exterior portion of the concrete in the arch ribs had hardened for four weeks, the pressure in the hydraulic jacks was increased to 400 tons per rib, and this thrust was sufficient once more to relieve the centering of its load.

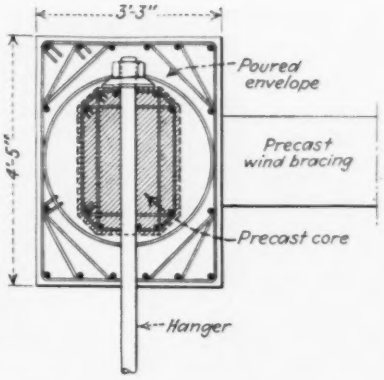


FIG. 6—ARCH-RIB SECTION in which a precast core is surrounded by a poured-in-place envelope.

A block of alumina cement concrete was then cast between the jacks, and these were removed as soon as the concrete had sufficiently hardened, whereupon the arch ribs were completed at the crown.

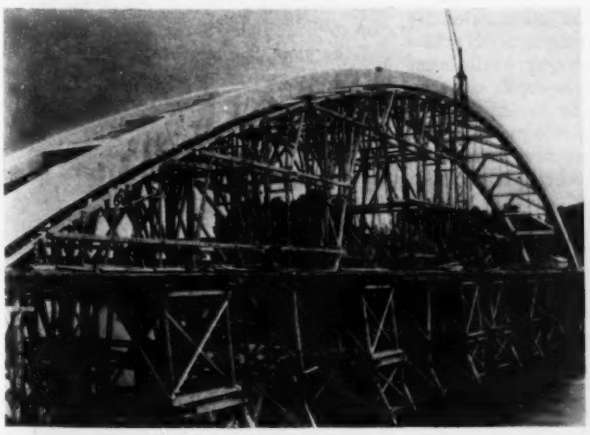
The arch cores remained bolted to the centering during all the foregoing operations, in order to prevent buckling in a vertical plane. The bolts, however, were arranged in such manner that a sliding of the core on the centering was not prevented.

The portion of the ribs below the roadway at the ends of the bridge were cast directly on the centering, together with the corresponding part of the decking.

The removal of centering was simply done by loosening the bolts referred to above. This had the effect of releasing the timber structure from ribs except in the vicinity of the horizontal members of the portal frames, where small jacks of a few tons capacity were employed to lift the arch free.

This construction procedure had two main advantages: (1) the centering was subjected to its maximum load prior to the concreting of the joints in the arch cores, so that practically no settlement of the centering took place during the subsequent operations, and no difficulties

FIG. 7—CONSTRUCTION VIEWS of 470-ft.-span concrete-arch bridge. Left: removal of centering after completion of arch and prior to deck concreting. Right: placing precast swaybracing members with steel buggies hauled on the rib centering. These same buggies placed the precast cores of the arch ribs.



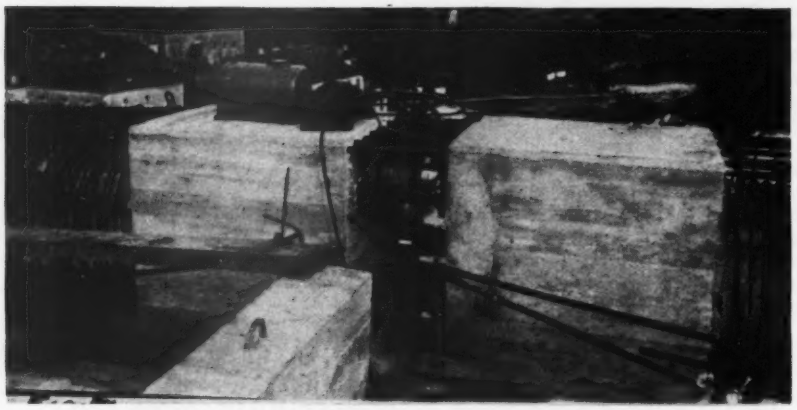


FIG. 8—HYDRAULIC JACKS inserted at the crown of the ribs, to lift the arch clear of the centering. View shows precast cores surrounded by reinforcing for poured envelope.

were experienced in maintaining the correct shape of the arch ribs; and (2) on account of the prestressing of the central core, the resulting stresses in the arch ribs, taking into account the bending moments from live load, etc., were more favorably distributed over the complete section than is usually the case.

After the completion of the arch ribs and windbracing, no further use was to be made of the centering, and this was therefore removed. The concreting of the decking was carried out on a scaffold suspended from the hangers. This deck concreting, between the two upper hinges, had to be carried out in sections in such manner that the load transmitted to the arch ribs through the hangers was at all times fairly evenly distributed, so as not to cause excessive bending moments in the ribs. Space was left between each two sections and, after all the sections had been concreted, extra load in the form of sand was placed in such amount as to equal the weight of the concrete not yet deposited. Then, during the concreting of the remaining portions of the decking, sand was removed at the same rate as concrete was being deposited.

While these operations were taking place, extra load was placed on the decking above the oblique pendulum (the portion between the abutment hinge and the middle hinge), causing this part of the structure to rest firmly on the falsework. The structure between the two upper hinges acted at this stage as a two-hinged arch and, in order to avoid temperature stresses in the decking, a joint was left at the center which was not closed until the removal of the falsework under the oblique pendulum was begun. This work being completed, the main structure began to function as a three-hinged arch, as intended.

Test loading

The bridge was subjected to a thorough test loading prior to being opened to traffic. During this test, both stationary loads (sand) and movable loads (trucks) were placed, to produce maximum stresses at various sections. The results of the test loading clearly demonstrated that the bridge structure, in spite of its slender dimensions, was extraordinarily rigid, the maximum deflection measured during the tests not exceeding 1/6000 of the span.

Personnel

The bridge was built by the main roads board, Department of Lot & Garonne, and the work was supervised by Mr. Hupner, chief engineer of the board, and Mr. Chamboredon, engineer of the board.

The plans and calculation were prepared by Establissements Christiani & Nielsen S.A.F., Paris, who have also carried out the work.

Slide Rule for Routing Floods Through Storage Reservoirs or Lakes

By Chesley J. Posey

Assistant Professor of Mechanics and Hydraulics, State University of Iowa; Associate Engineer, Iowa Institute of Hydraulic Research

A PROBLEM that frequently has to be solved by hydraulic engineers is that of determining the effect of reservoir, pond or lake storage upon a flood wave. This problem is important in the design of flood-control reservoirs and water-power developments, as well as in operation studies of existing works. A large number of methods of solving the problem have been published. Of these three are outstanding: (1) Harold A. Thomas' "direct graphical method" as presented briefly by him in "Flood-Retarding Reservoir Problem Directly Solved" (*ENR*, August 2, 1917, p. 226) and as elaborated in the Miami Conservancy District Technical Reports, Part VII, by S. M. Woodward; (2) a graphical method involving the use of the mass curve of inflow, described by H. K. Barrows in "Reservoir Storage Above Spillway Level," *Civil Engineering*, April, 1933, p. 233; and (3) a semi-graphical method described by George R. Clemens in "The Reservoir as a Flood-Control Structure," *Proceedings*, AM.Soc.C.E., May, 1934.

The slide-rule method described here is simpler to use than any of the above in that it involves no intermediate computations, no laying off of distances, and no graphical construction, except that which is done once and for all in the construction of the slide rule. It does require a separate set of scales for each reservoir having a different volume-depth or outflow-depth relation. If a single flood is to be routed through a reservoir, the slide-rule method has little or no advantage over the other methods, but for a number of floods the saving in time is considerable. Entering the slide rule with an initial outflow and values from the inflow hydrograph, subsequent values of the outflow and of the stage are obtained directly.

Before starting construction of the rule, it is first necessary to fix upon a certain interval of time, small with respect to the time of duration of the flood wave, as the length of step. Usually this will be equal to the shortest length of time between successive values on the inflow hydrograph available. It is not justifiable to use a shorter step, but a longer step is permissible if the changes of inflow are not too sudden. If there are 30 or 40 steps during the time of a single inflow flood peak, the outflow hydrograph will be established with satisfactory accuracy. Only one length of step can be used for each slide rule.

In theory the step should be short enough so that the average rate of outflow during the step can be closely approximated by the mean of the initial and final rates. Then, if t is the length of step, S_1 the storage at the beginning of the step, S_2 the storage at the end of the step, and i the average inflow rate, o_1 and o_2 being the outflow rates at the beginning and end of the step, respectively, we may write

$$S_1 + it = S_2 + \frac{o_1 + o_2}{2} \cdot t$$

or

$$it + (S_1 - \tfrac{1}{2} o_1 t) = (S_2 + \tfrac{1}{2} o_2 t)$$

which is in the form $A + B = C$.

If a constant length of step be used, A is a function of the inflow alone, while B and C depend solely upon the reservoir stage at the beginning and

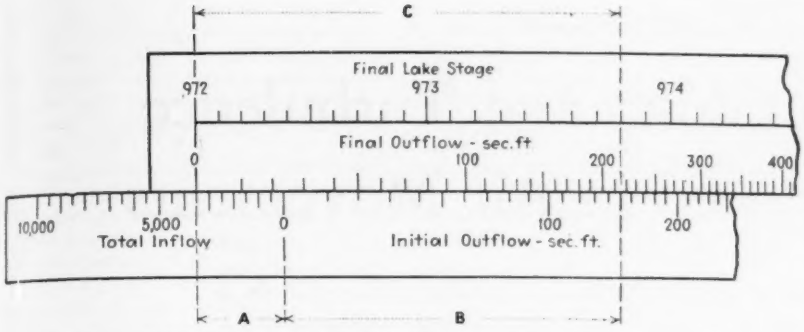


FIG. 1—SLIDE RULE for routing floods through reservoirs gives final stage and final outflow from a setting involving the known values of the total inflow and initial outflow.

end of the step, respectively, except where the outflow is not strictly a function of the head, which case will be discussed later. Where the outflow is a function of the head alone, B and C are functions of the initial and final outflow, respectively. Each term of the equation represents a volume. The unit of volume used should be the unit of the given inflow hydrograph times the unit of the length of step. Thus, if the inflows are given in cu.ft. per sec., and the length of step is t days, the unit of volume will be days × cu.ft. per sec., a unit commonly referred to as "day-sec.-feet."

A portion of a slide rule for solving this equation is shown in Fig. 1. The distances A, B and C represent the terms of the equation. The "total inflow" scale is so graduated that the distance A from zero to a value of total inflow is equal to *it*. The "initial outflow" scale is so graduated that the distance B from its left end to a value of outflow at the beginning of a step is equal to the value of $S_1 - \frac{1}{2} o_1 t$ corresponding to that outflow. The "final outflow" scale is so graduated that the distance C from the left end of the scale to the value of outflow at the end of the step is equal to $S_2 + \frac{1}{2} o_2 t$. The "final stage" scale is so graduated that the distance C from the left end of the scale to the value of stage at the end of the step is equal to $S_2 + \frac{1}{2} o_2 t$.

The rule is operated as follows: set the left end of the upper scale opposite the total inflow during the step on the "total inflow" scale. The outflow at the end of the step and the stage at the end of the step will then be found on the "final outflow" and "final stage" scales opposite the outflow at the beginning of the step, on the "initial outflow" scale. The slide rule shown in Fig. 1, as set, shows that if the outflow at the beginning of a two-day step is 150, the total inflow during the step being 3500, the final outflow will be 215 and the final stage 973.8. Only about one-third of the length of the rule is shown in the illustration. The rule is for Lake Traverse, two-day steps, and was made from data supplied by A. F. Meyer, consulting engineer. Typical

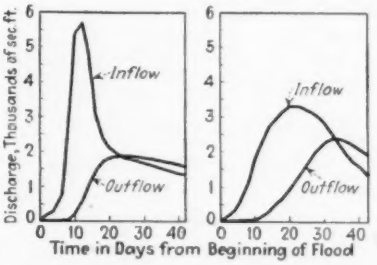


FIG. 2—TYPICAL OUTFLOW hydrographs plotted from results obtained by the use of the slide rule shown in Fig. 1.

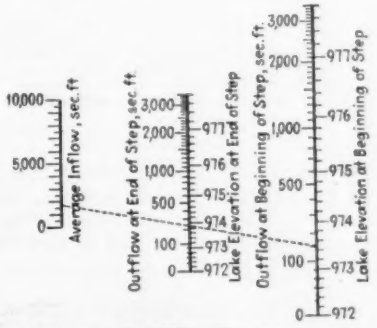

Average Inflow, sec.ft
Outflow at End of Step, sec.ft.
Lake Elevation at End of Step
Outflow at Beginning of Step, sec.ft.
Lake Elevation at Beginning of Step

FIG. 3—NOMOGRAPH which may be used in place of slide rule in cases where routing computations are not extensive.

outflow hydrographs computed with this rule are shown in Fig. 2.

In constructing several of these rules, the writer has found that a rule not over 2 ft. long will give results accurate to within 1 per cent, even though the scales are not divided with more than ordinary drafting-room standards of accuracy. Values of $S_1 - \frac{1}{2} o_1 t$ and $S_2 + \frac{1}{2} o_2 t$ can be computed at intervals of stage equal to the contour interval of the reservoir survey. Intermediate values required can be interpolated, assuming straight-line variation between the computed points. The scales may be drawn on the edge of a white pine board. A pencil may be used on the freshly planed wood, but if india ink is to be used the board should first be given a thin coat of transparent lacquer to close the pores of the wood. After the graduating is complete, a protecting coat of lacquer may be sprayed or lightly brushed on. Then the scale is ripped from the edge of the board and finished to a convenient size.

In many cases the values of $S_1 - \frac{1}{2} o_1 t$ will be negative at low stages. This is due to the step having a finite length, and will not cause any serious errors. It may be bothersome in constructing the rule, in that the "inflow" and "initial outflow" scales will overlap a short distance. Probably the best method of avoiding this is to give the negative values on a short scale below the inflow scale. It is interesting to note that any error in the assumed outflow at the beginning of a flood tends to disappear, and does so very quickly if the initial stage is low.

It has been assumed that the outflow is a function of the head alone. If manually controlled gates are used, and the gates are not operated according to a rule based solely upon the stage, this method may be impracticable. If, however, some manually operated outlets and some automatic outlets are used, the method can be used if the amount discharged through the manually controlled outlets is first subtracted from the inflow hydrograph. This can be done on the slide rule if a short "total controlled outflow" scale is added at the left end of the "final outflow" scale.

In order to gain full advantage of the convenience of this method, the rule should be planned so that no arithmetical computations are necessary when routing flood hydrographs. In studies of depth and frequency of flooding in the reservoir, the outflows are of minor importance, and a rule constructed for such studies should have an "initial stage" scale in place of the "initial outflow" scale shown in Fig. 1, and might well omit the "final outflow" scale. Similarly, if outflows were of prime importance, the "final stage" scale of Fig. 1 might be omitted. Another important point in planning the rule is to use a scale for the distance A, representing the total inflow, which will allow direct use of the available inflow hydrograph. For example, suppose it is desired to route several years of hydrograph through a reservoir, using one-day steps, and that the values in the inflow hydrograph are daily observations, taken at 12 o'clock noon. It would be best to consider a step as lasting from 12 midnight to 12 midnight, so that the value observed at 12 o'clock noon would represent the average inflow during the step. It is sometimes desirable to graduate the scale for distance A in terms of "average inflow" rather than "total inflow."

Instead of a slide rule, a nomograph may be used, as shown in Fig. 3. Many will prefer the nomograph where the flood-routing computations to be made are not extensive, or where details of the computations are to be published. In the writer's opinion the slide rule is more convenient to use and is more accurate for the same length of scale.

Aerodynamics and the Civil Engineer—V

Vortices, Eddies and Turbulence as Experienced in Air Movements

An attempt to summarize the broader aspects of the problem of air flow as they affect civil engineering considerations

By W. Watters Pagon
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THE IDEAL FLOW of air—the abstraction upon which much of aerodynamic science is based—concerns the civil engineer only in special cases because the effects of turbulence and roughness as well as the effect of sharp corners largely upset the flow, save on the forebody. Even here, as was shown in the first article of this series (*ENR*, March 15, 1934, p. 348), the theory of discontinuous flow, somewhat modified, gives a more accurate understanding.

Unfortunately for civil engineers, most tests in the field of aerodynamics so far have dealt with too low values of Reynolds' Number or with small models, so that it is necessary to extrapolate the result to large structures. On the other hand, in the case of buildings and bridges there is a negligible scale effect so that models of such structures may be tested in wind tunnels, with results that provide fair knowledge of the forces for which the design must be made. Such wind-tunnel studies were considered in the third and fourth articles of this series (*ENR*, Oct. 11, 1934, p. 456, and *ENR*, Dec. 27, 1934, p. 814). The second article in the series (*ENR*, July 12, 1934, p. 41) described how a vibration problem in a pair of tall stacks was solved by utilization of aerodynamic principles. In this article an extension is made of the science of aerodynamics, as it was outlined in the first article, and the effort is along the line of an attempt to coordinate and summarize the broader aspects of eddies and turbulence. At the beginning it is necessary to review some of the terminology and in particular to call attention to streamlines, friction and vortices. The necessary considerations with respect to turbulence and eddies may then be considered.

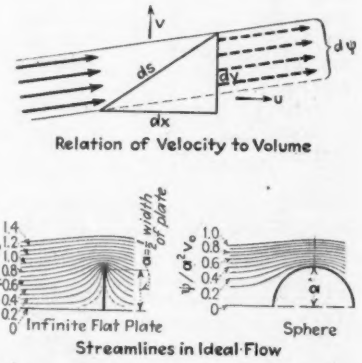


FIG. 1—SKETCHES of ideal flow, illustrating stream lines, each of which is a path along which passes a given volume of fluid per unit of time, designated as ψ flows.

Stream Lines—Consider a two-dimensional flow of ideal fluid across an element of surface of length, *ds*, in the plane of flow and of unit length normal to it. Let the flow be invariable with time (i.e. steady). If we call the volume $d\psi$, flowing per second through this area, $1 \times ds$, then $d\psi = vdx - udy$, where u and v are the component velocities in the X and Y directions (Fig. 1). The quantity ψ is called the "stream function." Any line along which ψ is constant (i.e. $d\psi = 0$) is called a stream line, because the flow is parallel to and does not cross it. Fluid particles move along stream lines in steady flows. The difference between values of ψ at two given points gives the quantity of fluid flowing across the line joining them. If stream lines be plotted, with ψ in equal increments, a crowding together of the lines indicates higher velocities, and a spreading out indicates lower velocities. This is because the quantity of flow between each pair of lines is constant at all sections (the equation of continuity); and as the area between becomes greater or less, the velocity becomes less or greater. Stream lines are everywhere normal to lines of equal potential, ϕ. Potential is an impulse that has been given the fluid. Velocity components, u, v and w, are its differentials with respect to x, y and z. Fig. 1 shows potential (ideal) flow about a flat plate and a sphere. At the margin of each sketch are noted the increments from which the stream lines were determined. For three-dimensional bodies the spacing is not uniform because of the increasing circumference of the annular spaces between stream surfaces as one goes outward from the body surface.

Friction—When one solid body slides over another, there is friction resistance. When a fluid of one density moves past another of the same or different density, there is also friction. Divide the solid body into thin slices, or laminae, like a pile of planks, and

FIG. 2—DISTRIBUTION of velocity in a viscous eddy.

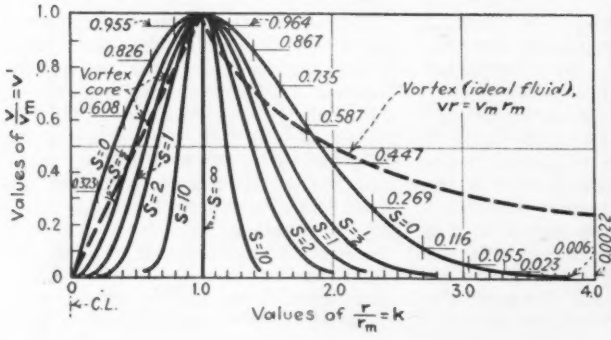
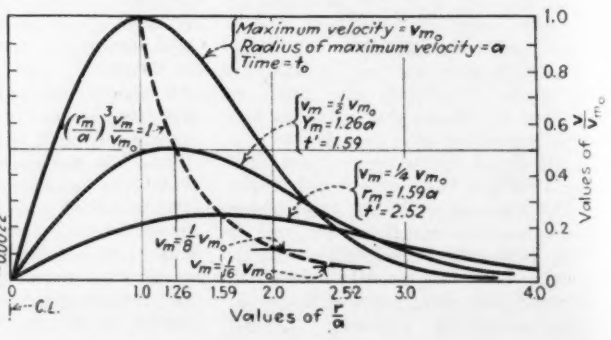


FIG. 3—VELOCITY and size of a viscous eddy at several ages.



push the upper planks longitudinally. If all slip uniformly, the pile will shear into a parallelogram. Similarly, if a fluid shears on all planes parallel to the contact face, the flow is called laminar flow, but slip is generally *not* the same at each lamina.

In a solid the resistance is called friction; in a fluid, it is called viscosity. The unit of viscosity, μ, is the force required to shear a 1-ft. cube of fluid into a rhomboid, with a relative velocity of 1 ft. per sec. between the faces. In a solid the shear is measured by the angle of distortion, because the shearing stress is uniform on all planes (of a small cube), and the end faces remain plane; in a fluid it is necessary to consider a closed line — or for three-dimensional flow, a closed surface — and to sum up the weighted velocities around it. Then, if each infinitesimal length, ds, has a component velocity of $v\cos\theta$ parallel to it, the summation of $v\cos\theta$, i.e. $\int v\cos\theta ds$, is called the circulation, and denoted by γ. Hence $\gamma = \int v\cos\theta ds$.

Vortices—Rotation about any coordinate axis is the ratio found by dividing the surface of an infinitesimal plane area (perpendicular to the axis) into the circulation about the periphery of the area. The complete rotation, or vorticity, at a point is the resultant of the three components of rotation at the point. *In an ideal flow* (by definition) *there is no rotation*, and if it contains a vortex the circulation is zero along every path except those which encircle the vortex filament. On these it is equal to the circulation (strength) of the vortex.

It is well to distinguish between a *rotational* and a *rotatory* motion. Call the perpendicular line through the infinitesimal area a *vortex filament*: then the (ideal) fluid circulating about this line as a nest of concentric tubes is called a *vortex*. The vortex is a mathematical abstraction in which the tangential velocity varies inversely as the radius, being infinite at the center and zero at a radius of infinity. Its stream lines are circles; the equipotential lines, radii. It is irrotational, though rotatory; but an *eddy* in a viscous fluid, as discussed later, does not vary in this manner and does possess rotation. If the mass of fluid should revolve as a solid body, it would form the simplest case of rotation, with vorticity of twice the angular velocity. Usually a vortex is diagrammed with a solid core, like the magnetic field about an electric conductor, to avoid the need for infinite velocity at the center. (See dotted line, Fig. 2).

Laminar Boundary Layer—An ideal or stream-line flow may be considered to resemble (in a sense) a wide, deep, placid river flowing with a mirror-like surface; or tobacco smoke moving slowly, but stringily, across a room and looking very much like a diagram of stream-line flow. Follow a circuit along one stream line, across to the next, back along this, and then across to the point of beginning. There will be no shear, or circulation, around such a circuit—i.e. no rotation—because, by definition, the ideal fluid is irrotational.

In reality, however, air and other fluids do not move freely past a body as in the ideal flow, but adhere to the surface. The first infinitesimally thick lamina slides slowly past, shearing as it goes; the outer ones do likewise, but faster. When (as in Stokes' range), the velocity is low, and always for the fluid very near the surface, the motion is laminar. It is this very thin layer near the surface that Prandtl has named the "boundary layer." It is untroubled and placid. Its thickness is usually defined as the distance from the body surface to where the velocity is 95 per cent of the velocity of the stream-line flow, because the last 5 per cent changes very gradually. The boundary layer possesses rotation.

Turbulent Boundary Layer—Outside the boundary layer, if the velocity is great enough, there is turbulence; hence this is sometimes called the "turbulent boundary layer." A photograph of smoke drifting close to a flat plate shows placid conditions for some (parallel) distance; then it riffles, as in the surface of a river; then it eddies, growing rapidly and absorbing all of the vorticity of the agitated smoke; and then, the eddies are projected into the body of the fluid, as stones leap from a streambed in what is known as *saltation* (but again fall back by gravity). Finally each eddy diffuses and dissipates, like steam from a stack in a gentle breeze.

Two points deserve consideration: (1) What causes the inception of turbulent flow? and (2) What is the effect of saltation of the eddies?

Wave Motion—In Lamb's "Hydrodynamics" will be found an extended analysis of wave motion at the surface between two fluids, as air and water. Since turbulence means much to the engineer, it is worth studying wave formation.

At such surfaces of discontinuity there is instability, tending toward wave formation. A light wind of ½ to 1 m.p.h. will start ripples on a water surface, but the viscosity and surface tension of the water soon destroy them. Given a higher velocity, the waves persist. By test of a fixed model wave, it has been found that pressure and suction are developed such as to increase the height and depress the trough; also to create a forward propelling component. If the wave height becomes too great, so that the propelling force on the crest overthrows it, a white cap forms in spite of the surface tension, and foam saltates into the air, to diffuse as mist and salt spray. Water waves, as observed, all differ in height, shape and length, because they are composed of series of different characteristics, but in general they have a fairly constant period for any given wind direction.

Hydraulic Jump—Water running rapidly down a channel in a shallow stream, retarded slowly as it goes, finally comes to an unstable condition and forms a *hydraulic jump*. In a venturi tube or a pipe expander or a sudden change in pipe diameter, the jump occurs, to permit the enlargement of flow and the reduction of velocity. At the flanks of a circular cylinder a sudden thickening of the air boundary layer has been found just before the point of separation of the discontinuous surface.

Inception of Turbulence—About 50 years ago Osborne Reynolds studied the inception of turbulence in water in a pipe. For a distance from the tube mouth a thread of colored liquid allowed to flow into the stream remained a clear, stream-line streak, then suddenly diffused throughout the cross-section. Up to a determined value of vD/ν, where D is the pipe diameter, he found it possible to obtain laminar flow, but above this value he obtained only turbulent flow; hence this ratio is called after him "Reynolds' Number." For bodies, D is a body dimension.

From this we may generalize, for flow along a body surface; first, all laminar flow; second, instability of the outer part of this flow; third, a wave motion in the outer part; fourth, either a fluid jump, causing sudden enlargement of the boundary layer as observed in tests of cylinders, if inception be all at one spot, or saltation of eddies at many spots; fifth, diffusion of the eddies into the outer mass, causing a retardation of this mass, because the eddies have less forward velocity than the outer flow.

Eddy Conductivity—This leads to a discussion, from the purely physical point of view, of viscosity, and of what Taylor has called "eddy conductivity." In Maxwell's theory of heat, the molecules of a fluid are in violent motion in all directions, with frequent impacts between them, as with balls on a billiard table. They have a "mean free path," speaking statistically. When the molecules in a fluid moving past a body strike the surface, they are deflected in all directions if the body is *molecularly smooth;* but if the roughness is large with respect to the mean free path and to the size of the molecules, there is general retardation as a whole. As the retarded molecules near the body bound outward, they partly transfer their diminished forward motion to others in outer layers, so that all layers near the surface are retarded. This is viscosity, and the friction per unit area on the body surface is the coefficient of viscosity, μ multiplied by the rate of change of velocity measured perpendicular to the surface.

In turbulent flow there is a further interaction due to the transfer of momentum between adjacent layers as a result of the saltation of eddies. Taylor, in England, and Prandtl and Karman,

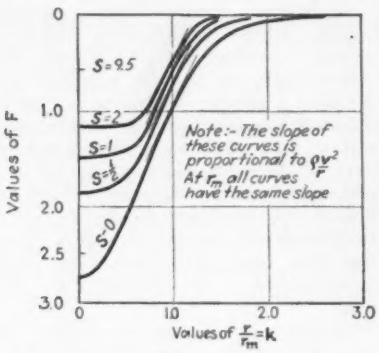


FIG. 4—VALUES of F in pressure equation of viscous eddy where F is a function only of k and S.

in Germany, followed out Reynolds' expression. They argue that if u' and v' are the velocity fluctuations—i.e., the plus or minus difference between the actual velocities and the steady velocities u and v—then the *apparent shearing stress*, or *turbulent friction*, has the value $-\rho\overline{u'v'}$, where the bar means the average or mean value, over a period of time, of the products $u'v'$ at all instants—in other words, the statistical average of these products. If there are fluctuations in three directions, they are expressed as u', v' and w', and these characterize the turbulent flow at a given point.

Just as in the Maxwell molecular theory there is a mean free path, so does Prandtl assume a *mixing length*, meaning that as eddies are displaced at right angles to the flow they carry with them their original undiminished momentum, and travel out a certain distance perpendicular to the flow.

For low Reynolds' Numbers the laminar friction is preponderant, but at high numbers it is negligible, except in the near vicinity of the body surface.

Skin Friction—In 1904 Prandtl evolved a theory for laminar skin friction for flat plates parallel to the flow, showing that the boundary layer increases in thickness as the square root of the distance x from the leading edge; that the unit friction varies as the 3/2 power of the velocity and inversely as the square root of x; and that the unit friction and total friction vary inversely as the square root of a Reynolds' Number R_f, in which the distance D is the length x. Clearly at high velocities, or at large values of x, the skin friction is very small.

There is found a critical region for R_f at which the friction slowly changes from the laminar value to a higher turbulent value, after which it follows the latter curve.

In the laminar layer the variation of velocity with the distance from the surface seems to vary approximately as the square root of the distance; for the turbulent flow, as the one-seventh or one-eighth power. Karman has shown for the latter a logarithmic variation; hence for high values of R_f even smaller powers appear to hold. On a 1/40 scale model of the U.S.S. "Akron," Freeman found very close agreement between test and theory, when he used a coefficient of 1/7.

Thom derived theoretically a formula for the skin friction on a cylinder, $C_f = \frac{4}{\sqrt{R}}$, and when he deducted from the total drag (as found by experiment) the portion of this drag that is represented by test pressures around its circumference, he found a close agreement with his formula. This indicates that for $R = 10{,}000$, $C_f = 0.04$, and for $R = 10{,}000{,}000$, C_f is negligible. Thom found that the ratio of the boundary-layer thickness to the cylinder diameter varies as the square root of R. Fig. 5 shows the correlation of drag to the periodicity of the eddies. The correlation should probably be exact, and in fact it is good except at the critical region. The change of pressure distribution is seen in Fig. 6.

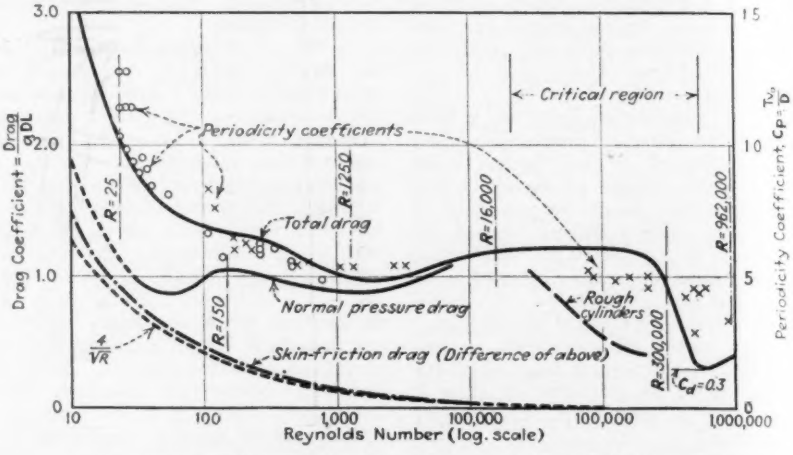


FIG. 5—DRAG COEFFICIENTS and eddy frequency for circular cylinders. Eddies are stationary and symmetrical below $R = 25$. Based on tests of Thom, Relf and Ower. In periodicity coefficient, T is time in seconds between passage of two successive eddies in one row, v_0 is the approach velocity in ft. per sec., and D is the diameter of the cylinder in ft.

Surface roughness

Surface roughness—Nikuradse attempted to determine a standard of roughness by gluing uniform-sized sand grains to test specimens, and other sizes in other tests. He found considerable correlation between different roughnesses. If the average height of the grains is proportional to the diameter of a pipe, he found experimentally that similitude holds. But no one as yet has evolved a basis for appraising helter-skelter, or statistical, roughness other than this. Fage believes that practically all the resistance in a pipe is due to form resistance of the roughness, and to eddies behind each projection.

Tests of the flow about cylinders show that the eddy formation is very sensitive to the surface roughness at angles between 65 and 90 deg. to the stagnation meridian. Introduction of artificial roughness in this region induces turbulence at lower values of R, so that the critical region of Fig. 2 (*ENR*, March 15, 1934, p. 348) is essentially a function of roughness. (See Fig. 7 for cylinders wrapped in sandpaper.) Prandtl found early that a fine wire about the forebody of a sphere produced a remarkable change in its drag coefficient. Projections of the sort, if completely immersed in the laminar sublayer, seem to have but little effect, but larger ones are important.

Eddies

The mathematical vortex has already been defined. Such a pattern cannot persist save in a frictionless fluid, and then only about a fluid rotating as a solid core, to avoid infinite velocity at the axis. A vortex tube must either be of infinite length or it must terminate at a boundary surface, or must be a ring. In Fig. 2 the dotted line shows such a flow, with a core radius denoted by r_m.

Taylor has solved the differential equation for *viscous eddy* flow and obtained a complex exponential formula, which can, however, be diagrammed simply. The tangential velocity is zero at the eddy center and at infinity; at any given time, t, it has a maximum velocity at a radius (similar to that of the core), which we will r_m, such that for air $r_m = t/57$, in ft., for t in sec., and in standard atmosphere, elevation zero. At any other radius, r, where $r/r_m = k$, and $v/v_m = v'$, $v' = ke^{\frac{1}{2}(1-k^2)}$, and $e = 2.7183$, the base of natural logarithms. Eddies dissipate in time due to viscosity; hence if a denotes the value of r_m at time, t_0; and if at time, t, the maximum velocity has reduced to $\frac{1}{n}$th, then $t - t_0 =$

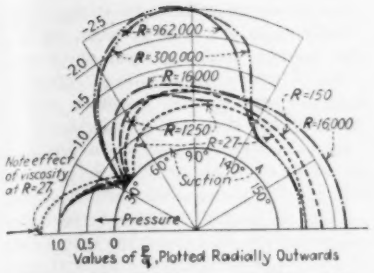


FIG. 6—PRESSURES on a cylinder, with wind from the left and for various values of Reynolds' Number R.

$3200\ a^2\ (n^{2/3} - 1)$. For example, for $n = 2$, and for a ¼-in.-dia. eddy, $t\text{-}t_o =$ 0.18 sec. In Relf and Lavender's tests the effect of eddies (from a ¼-in. mesh screen placed 4 ft. in front of a model in a wind tunnel), on the drag of the model, was found to be reduced by half in about 0.1 sec., or about one-half of that just computed, indicating perhaps some additional dynamic effect (such as end flow into the axis of the eddy). Such a flow might become a radial outward flow from the bole of the eddy, and the inward flow at the end would act like the inward flow into the lower end of a tornado or waterspout. (This will be discussed later.) The time to dissipate is clearly proportional to the radius squared; hence when the velocity has become $\frac{1}{n}$th, the radius r_m has become $an^{1/3}$.

The radius at which the velocity is 0.0022 (about ¼ per cent) of the maximum, (the radius for zero velocity being infinite) is approximately $4r_m$. The pattern of the velocity distribution is always as shown in Fig. 2, the curve marked $S = 0$. In Fig. 3 are shown, relatively, the velocity and size at several ages.

If at the ends there is uniform inflow or outflow, producing radial outward (or inward) side flow, of value $S = 3200ru$, where u is the radial velocity at radius r, and where, of course, by the equation of continuity ru must be constant, Bateman has obtained the general solution. He shows that: (1) the velocity variation with time is the same as Taylor's (i.e. $S = 0$) raised to the power $(2S+1)$; hence the curves of Fig. 2 show the eddy pattern for several values of S and the trend with increase of S; (2) that the velocity scale is inversely proportional to the 3/2 power of the age ratio, $t' = t/t_o$; (3) that the radius scale is proportional to $(t')^{\frac{1}{2}}$; (4) that for different values of S (but the same age, t,) r_m is proportional to $(2S+1)^{\frac{1}{2}}$.

The energy of transverse (i.e., rotary) motion is inversely proportional to $(t')^2$. The angular momentum remains constant with time, which merely signifies that as the eddy grows in size it diminishes in velocity, so as to comply with the principle of the conservation of momentum. It may be noted that only for values of S that are multiples of ½ are finite values of pressure possible, indicating that only under certain conditions can such flows exist, perhaps changing abruptly from one regime to another. The pressure at time t can be expressed as: $p + \frac{1}{2}\rho u^2 + \frac{1}{2}\rho v^2{}_m F = C'$. The coefficient F, which is a complex function of r and S, is given in Fig. 4; C' is the pressure at a great distance from the eddy center. The term $\frac{1}{2}\rho u^2$ is the velocity pressure of the radial flow, and $\frac{1}{2}\rho v^2{}_m F$ is the centrifugal pressure. The equation is in Bernoulli's form but differs by F, because the eddy is a *rotational* phenomenon. The corresponding equation for a vortex is $p + \frac{1}{2}\rho u^2 + \frac{1}{2}\rho v^2 = C$, for all points outside the core.

If, as Webb suggests, this eddy pattern applies to a tornado, then at the axis there is only high suction; proceeding outward the suction diminishes and also the radial velocity u, but the tangential velocity v increases to a maximum at r_m. The conditions at the end of the eddy (tornado) near the ground have not been solved mathematically, but as the storm approaches, the barometric pressure declines rapidly and buildings may explode unless adequately vented. In the St. Louis tornado of 1896 the maximum barometric drop was 13 per cent, or 275 lb. per sq.ft. Webb applied his results to a tornado recorded in South Wales and believed that the results as to growth and dissipation were of the right order. (However, it must not be forgotten that most storms are self-sustaining through the energy obtained from the condensing water vapor.) It would appear that S has a high value, hence F is small. Thus v may be very high; but of equal importance, the increase in v as the tornado passes will be very rapid.

Referring to Relf and Lavender's results, Webb says: "Eddies furnished by a cylinder of ¼-in. diameter, suspended in a stream of air, will die away by viscosity alone if the wind speed does not exceed 1 f/s; at higher wind speeds the dynamic effect is not negligible. Eddies so formed have an initial tangential velocity equal to about 3 per cent of the wind speed. There is a radial flow in eddies equal (at the ring of maximum velocity) to between 1 and 2 per cent of the tangential velocity."

In September of last year a navy officer flew around a waterspout at the mouth of the Chesapeake Bay. "The spout's top ended in the clouds, 1,000 feet above the water. Dark and funnel-shaped, it appeared to me to be based in a white ball of spray about 125 ft. in diameter. Then it narrowed abruptly to about 30 ft. and spread out to about 100-ft. diameter at the top." The quotation is from a press dispatch.

A mass of cold (polar) air passing one of warm (equatorial) air, as in the polar front theory of Bjerknes, can account for the cyclonic storms which periodically pass over the country, with an eddy diameter of 1,000 to 3,000 miles.

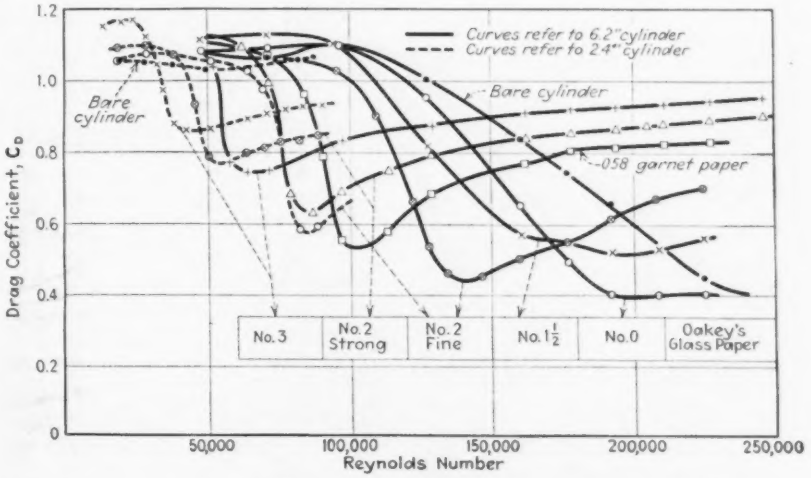


FIG. 7—EFFECT OF SURFACE ROUGHNESS on drag coefficients of cylinders wrapped in sandpaper. (From Fage and Warsap.)

The eddies shed by a body completely determine the complex flow in the wake. (Refer to Figs. 5 and 6.)

Turbulence

Turbulence has been defined by Karman to mean irregular fluctuations of velocity governed by some statistical equilibrium. Wind, as we know it near the earth's surface, is gusty. Eddies peel off the corners of every building, and large horizontal rollers come from every hill-top. Any one living where there are many trees has heard the sound of an approaching gust that roars through the woods, swaying trees, rattling window-panes, and then slowly hushing as it goes. Every leaf on every tree, every twig and branch, emits a vortex street of eddies. From a high window, sheets of rain show every gust clearly. An approaching squall ruffles and darkens the water surface as it comes. Once when flying at about 1,000

ft. over the north shore cliffs of Long Island I felt as though my head would roll off because of the turbulent boiling upward of the wind as it passed over the cliffs. At 3,000 ft. there was no such effect.

In *Civil Engineering*, 1932, are shown graphic records of gusts as recorded by the University of Minnesota. At Pye-croft Chimney, Taylor recorded velocity changes, u', v' and w', of almost equal values. He determined the approximate widths of the velocity and direction traces, thereby establishing the maximum velocity, and the maximum change of direction. He concluded that over a period of time the average values of these velocity components are equal. Calling ϕ the maximum position of the weather vane in any direction, he approximately sets $\sin\phi = \frac{\frac{1}{2}(u_{max} - u_{min})}{\frac{1}{2}(u_{max} + u_{min})}$

The fraction expresses gustiness. From a study of 27 records, in which 2ϕ varied from 3.5 to 78 deg., the mean speed from 5.0 to 25.3 m.p.h., and the range of gustiness, from 10 to 62 per cent, he found a remarkable agreement, the points falling equally above and below the line. To give a few of the records:

Date (1917)	Time, P.M.	ϕ Deg.	$\sin\phi$	Gustiness, Per Cent	Av. Vel. M.P.H.
July 2....	5	39	0.62	0.63	12.3
July 2....	10	5.9	0.10	0.10	13.7
Generally gustiness and change of direction are east at night.					
July 6....	6.20	24	0.36	0.40	14.0
July 6....	8.30	15	0.26	0.24	11.3
July 6....	11.40	10	0.17	0.17	12.7

Scrase found the lateral component v' to be greater than the vertical component w', but he found all components to be proportional to the average wind speed u, when above about 13.5 m.p.h., and he expressed the belief that this is true at lower speeds.

Let us now review some of the results of measurements in wind tunnels. The earlier variable density tunnel of the National Advisory Committee for Aeronautics proved to be very turbulent owing to a "honeycomb" placed in the oncoming stream, to straighten out the flow, but situated quite close to the model so that there was not time to dissipate the eddies. (The use of high pressure, therefore high density, makes possible Reynolds' Numbers greater than otherwise, since the density appears in the numerator.) Tests in this wind tunnel on spheres above the critical range agreed well with tests made by dropping spheres in free air, perhaps because of similarity of turbulence. Dryden and Heald made an extensive study of the effect of turbulence on drag of models, in order to correlate this tunnel and others abroad which showed differing results. Cylinders varying from 0.0085 to 3 in. in diameter were placed behind screens of 0.011-in.-diameter wires spaced at 1/16-in. mesh, and at distances behind the screen of 36 and 8 in. from the model center line. It is of interest to note that a single wire caused a large percentage of the effect of a whole screen; that different sizes of this wire caused markedly different results; and that when the wire was $\frac{1}{2}$ in. off the median plane of the cylinder, the effect largely disappeared. As this single wire was moved progressively toward the cylinder, the change was equally noteworthy. Fine wires attached to the cylinder at the 45-deg. meridian acted similarly. In general, there results showed a displacement of the critical value of R from 320,000 to 50,000. (See *ENR*, March 15, 1934, Fig. 2; also Fig. 7 of present article.)

Ahlborn, by means of powder strewn on the surface of water, so that the streamflow could be photographed, found that if a square-bar screen is placed just before a cylinder, there is a marked difference according as a screen bar, or a space between bars, is directly before the stagnation meridian. When the space was aligned, the eddies caused a reduction of turbulence; when the bar was aligned, there was no apparent effect because the eddies were of like sign. This accords with the effect of displacing the $\frac{1}{2}$-in. wire from the median plane, as just noted above. (Refer to Gould St. Stacks, *ENR*, July 11, 1934.)

Dryden and Kuethe, at the Bureau of Standards, have studied the general subject of turbulence most thoroughly. Following Prandtl and Blasius, and assuming a velocity variation in the turbulent layer according to the 1/7th power, they find a result that agrees well with Wieselsberger's tests. In order to organize their work, they define turbulence as the ratio between the variable velocity and the mean or average value, where *mean* signifies "root mean square" because the hot-wire anemometer which they use gives this. Then 1 per cent turbulence means a sinusoidal variation of 1 per cent of the average, hence 1.4 per cent maximum variation.

They compared tests in three different tunnels, to find how the critical value of R varies, defining the critical value as that at which the drag coefficient has fallen to 0.3, (see Fig. 5) and find:

Turbulence, Per Cent	Critical Reynolds' Number R_c
0.5	270,000
1.0	232,000
1.2	197,000
1.6	164,000
2.3	132,000

This indicates a marked diminution of R_c with increasing turbulence. (See Fig. 7 also.)

They also give an oscillograph picture of variations of speed near the tunnel wall, showing a variation at about the 0.15, or 1/6.7, power, and indicate that at all sections the velocity fluctuations are proportional to the mean velocity u at the same point.

At a clear distance of 0.1 dia. in the wake behind the cylinder, there is marked evidence of the eddies—i.e. $\Delta v/v_0 = 8.8$, but at 4.2 diameter there is only a slight sine wave variation, indicating the almost complete decay of the eddies in a distance of 4 diameters. At the near section the velocity variation is from 136 to 34 per cent of the average; at the far section, 102 to 90 per cent.

California Irrigation Districts to Get Aid From Federal Loans

More than one-third the districts have applied for RFC aid—Of the outstanding bonds, 70 per cent are in default—Total area of 90 districts is 3,200,080 acres

NOW THAT RFC LOANS have been approved for 34 of the 90 active irrigation districts in California, it is expected that on the whole the financial obligations of water users there will be reduced by one-half. The total area of the 90 districts is 3,200,080 acres, of which half (1,679,676 acres) was cropped in 1933. Total acreage has not changed materially in recent years; some areas have been abandoned, but as additional area has been brought in elsewhere the changes tend to balance. The value of improvements required to bring water to these districts may be estimated from records of total cost (exclusive of that done by the individual on his own property), which show an expenditure of about $150,000,000, or approximately $50 per acre. Of the total $91,715,000 in outstanding bonded indebtedness last summer, $63,692,000 (70 per cent) was in default on interest payments, and each interest date was adding to the list of defaulters. California's state-aid ventures in irrigation colonization, the Durham and Delhi districts, begun in 1918 and 1920, respectively, did not succeed and ultimately were abandoned in so far as state aid is concerned.

Of the active districts 86 per cent have bonded indebtedness, which varies from a minimum of $52,000 to a maxi-

mum, in the case of the Merced Irrigation District, of $16,190,000. Most of these bonds bear interest at 6 per cent, a rate which has become relatively high enough to be a strong inducement to apply for an RFC loan with its attractive 4 per cent interest, not to mention the reduction in principal usually embodied in such refinancing.

Of the districts that have so applied, the larger number (34) have obtained approval and are proceeding to qualify for the loan. Progress toward this end is in various stages. In seven districts the bondholders have been paid; in some the process of getting the bonds deposited has just started, and some time will elapse before the necessary 90 per cent of the outstanding bonds will be deposited under the escrow agreement. Thereafter bondholders are paid with RFC funds in amounts varying from 23 to 76c. on the dollar. This percentage is the ratio of the amount of money paid (refunded on outstanding bonds) to the amount of the outstanding loan (bonded indebtedness on the property).

For example, in the case of the Merced Irrigation District with its outstanding bonded indebtedness of $16,190,000, an RFC loan of $8,600,000 was applied for and approved, which will bring the bondholders in exchange for their bonds 51½c. in cash for each dollar in face value. This district also affords an example of how the RFC loan is to benefit the water users: instead of having to meet $1,100,000 in principal and interest charges as heretofore, after the loan reaches maturity (three years) the district's principal and interest charges will total only $460,000. Some bondholders are expected to hold out, and petitions in bankruptcy are being prepared to force them to come in. Legal contests by unwilling bondholders may be expected in some cases.

Not to be overlooked in examining the present features of the refunding situation is the fact that attempts were made in California over a fifteen-year period to strengthen the irrigation district act so as to make district bonds salable. The success of those endeavors is attested by the fact that some $100,000,000 of such bonds were sold. Bond sales ceased when the depression came, and since then the irrigation district act has been amended so as to reduce or eliminate tax-deliquency penalties and permit reduced assessments sufficient for operation costs only. Recent federal legislation provides procedure under which a district may go through bankruptcy if two-thirds of the bondholders consent to the refunding program. Under this procedure the terms of the refunding program become binding on the non-consenting bondholders. These provisions have largely eliminated the bargaining advantages of the bondholders in negotiations leading to refunding plans. Tax-relief acts have gone so far that many districts now are becoming alarmed for fear they will not be able to collect even operating costs.

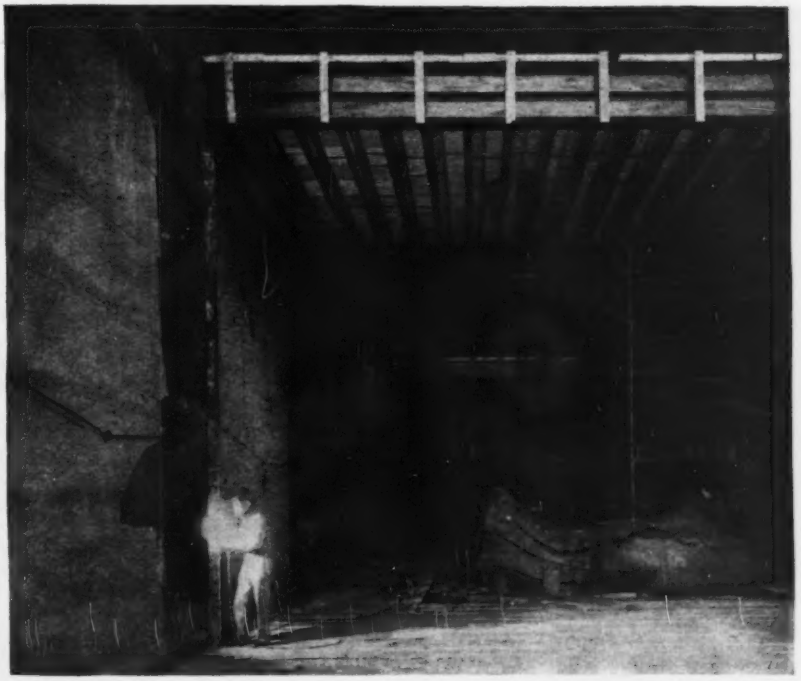
Terms on refunds offered under the RFC loans are thought to be based on the lowest price the bondholders could be induced to accept rather than on the ability of the district to pay. The terms proposed for some of the San Joaquin Valley districts are in interesting contrast to values used in estimates on the Central Valley project. For example, the refunding program of the Merced District can be carried almost entirely from byproduct power revenues, leaving the lands subject to only small assessments in addition to operation and maintenance costs, while present negotiations in relation to the Central Valley project are being conducted on the basis of a price of $5 per acre-foot of regulated supply and $1 to $2 for unregulated water. These prices are at the main canal; in addition, all costs of local operation and groundwater pumping will have to be met by the landowners.

In the more arid sections of the San Joaquin Valley, where dependence heretofore has been largely on pumped supplies, the seriousness of water shortage has been steadily increasing in recent years. For many years the water table lowered steadily, until it is now 75 to 150 ft. (according to location) below the level prevailing when irrigation pumping came into vogue. Recent years have been low in rainfall, and there has been nowhere near enough inflow to replenish the drawdown resulting from pumping.

Welding Aids in Building Indianapolis Store Addition

IN ERECTING a nine-story addition to the Block Department Store in Indianapolis, arc-welding was used in strengthening the exterior wall columns of the existing building and in assembling galvanized corrugated sheet-iron, which was laid to form a support for the concrete floors during pouring. In strengthening the wall columns, steel plates were welded to the flanges, extending from the basement to the top floor. At the basement level, according to the General Electric Co., these plates were 14 in. wide by 2⅛ in. thick, the sizes being graduated on the way up until, at the top floor they were 10 in. wide by 1¼ in. thick. Intermittent fillet welds were used, 3 in. long spaced 6 in. end to end. One-half inch fillets were built up in a number of passes, using a ⅞-in. electrode. For the corrugated sheets ¼-in. electrodes were used.

REINFORCING COLUMN by welding on additional flange plates. Existing building is at left, and in the new nine-story addition the corrugated sheets used for concrete forms are shown.



Research Notes

Current Work at Lehigh University

ABOUT A YEAR AGO (*ENR*, Feb. 15, 1934, p. 225), the original article in this series was devoted to the current research work at the Fritz Engineering Laboratory of Lehigh University. Since then articles have been published on work at Ohio State University (*ENR*, May 24, 1934, p. 666), and at Wisconsin University (*ENR*, March 28, 1935, p. 455). —EDITOR.

MUCH PROGRESS has been made during the past year on research projects at the Fritz Engineering Laboratory, Lehigh University, Bethlehem, Pa. Investigation of torsional stresses in structural steel sections has been completed. (See April issue of *Proceedings*, Am.Soc.C.E.) The importance of this investigation for the practical engineer is manifested by the fact that the new (1934) "Bethlehem Manual of Steel Construcion" contains the design formulas recommended in the report and lists the torsional constants for all the common shapes of rolled sections. The immediate application of research studies to the practical problem is thus illustrated in a gratifying manner, the industry making use of the design method immediately the scientific relationships have been established.

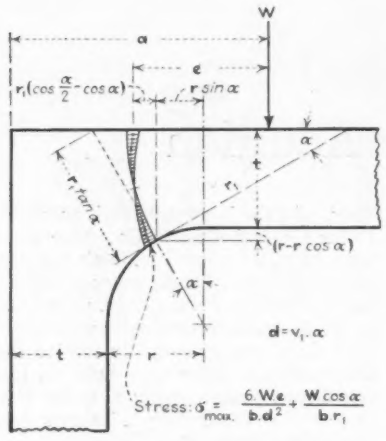


FIG. 1—THEORETICAL analysis of a structural angle used as a beam seat.

Welded connections

An investigation on welded seat-angle connections, carried out in cooperation with the structural steel welding committee of the American Bureau of Welding has also been completed. This investigation was carried out by means of tests of model connections as well as tests of full-size beam to column connections, supplemented with photo-elastic studies of bakelite models (results to be published in full in the *Journal*, American Welding Society). The study resulted in a recommended new method of analyzing seat-angle connections.

The angle is designed for bending by the method illustrated in Fig. 1, the weld is designed in simple shear, and the beam is designed for compressive stresses in the web, or in other words, for what is termed "crippling." The agreement between the values computed by the proposed method and the results of the tests is shown in Fig. 2.

The photo-elastic apparatus has been found to be an excellent means for supplementing laboratory experiments of structural materials. The stress concentration at certain points in plane sections is readily adapted to photo-elastic studies, and in the seat-angle investigation the photo-elastic results served as a guide in the development of a rational theory of design. The unusual distribution of shearing stresses in a seat angle subjected to bending is well illustrated in Fig. 3. The great beneficial effect of large-size fillets of angles was readily seen from these studies. At present, experiments are under way for the study of stress distribution in spoke wheels and of stresses in rigid cross-connections.

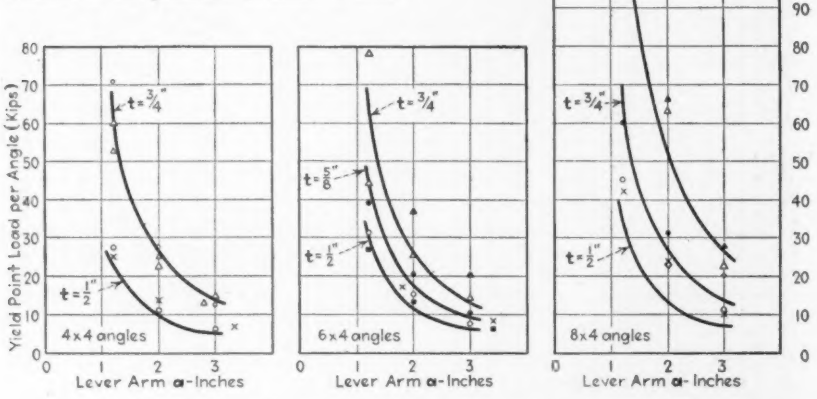


FIG. 2—AGREEMENT between computed strength (curves) and test results (plotted points) of welded seat angles as related to various positions of the load.

Soap-film studies

The soap-film analogy for the study of shearing stresses was made use of in the experimental study of effect of size of the fillet on the torsional rigidity of structural beams. About 60 different structural shapes were thus analyzed for torsional rigidity. The experiment brought out the importance of large-size fillets for beams subjected to torsional loads. Further application of the soap-film analogy is at present under way for the study of bending problems and for the determination of the sum of the principal stresses at any point in a section. In the photo-elastic experiments the difference in the principal stresses is obtained directly so that the combination of these two methods will fully evaluate each of the principal stresses.

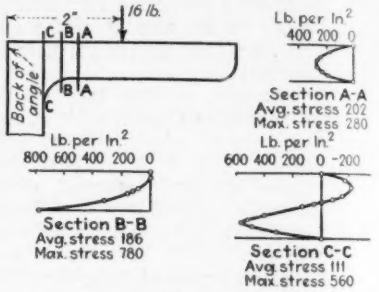


FIG. 3—SHEARING-STRESS distribution at various sections in a 6x4x⅝-in. seat angle subjected to bending.

Steel floors

Experiments have recently been begun on thin steel-plate steel floors. This investigation is carried out in cooperation with the American Institute of Steel Construction and the McClintic-Marshall Corp. The research committee of the Institute (Aubrey Weymouth, chairman) is sponsoring this study. The experimental part will principally be carried out on model steel floors of one-third size ratio, with plans for a supplementary test of a full-size 10x40-ft. floor panel loaded by means of hydraulic jacks. A photograph of the first steel-floor model is shown in Fig. 4. It is hoped that these experiments

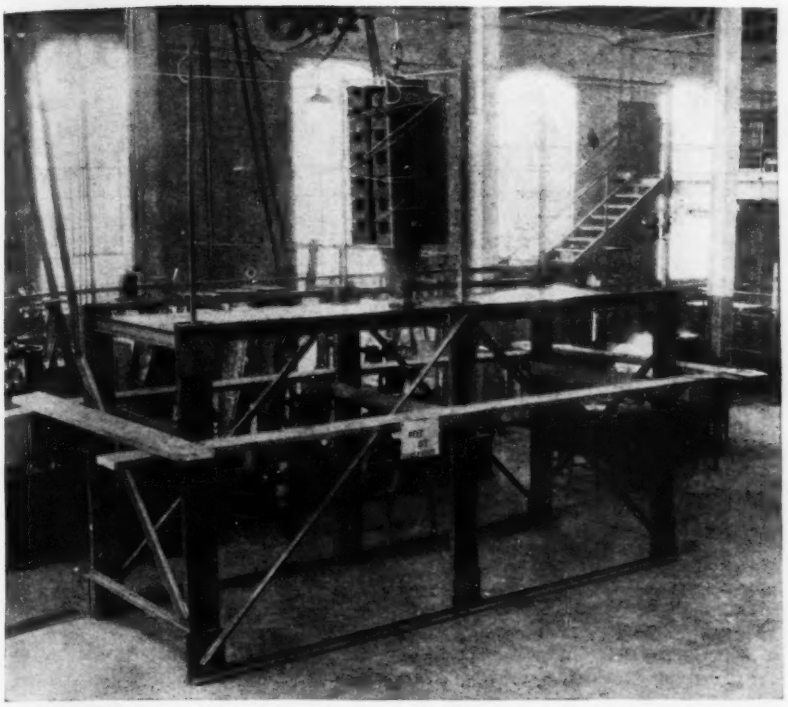


FIG. 4—STEEL-FLOOR test model of "battledeck" construction being used in an investigation to determine a rational method of design.

will yield information from which a rational method of design may be developed.

An investigation of stress condition and strength of wire ropes bent over sheaves of various diameters is now under way, in cooperation with the Wickwire Spencer Steel Co. A photograph of the loading rig is shown in Fig. 5.

Cement studies

The studies in concrete have been continued. An investigation of the effect of brand and type of cement on strength and durability of concrete was recently completed (January-February, 1935, *Journal*, American Concrete Institute). This study included thirteen brands of standard portland cements and five special high-early-strength cements. The results indicated that the method of manufacture of cement is probably the one factor which contributes most to the great variations in quality of the concrete. The strength and durability of the concrete with the various cements are given in Fig. 6. In spite of the fact that all the thirteen brands of standard portland cement came from the Lehigh Valley district and had substantially the same chemical composition, considerable variation is noted in the results. It seems timely that more attention be given to the problem of the manufacturing process of the common cement, in addition to the efforts spent on the question of chemical compounds. Attention should also be called to the fact that a material economic advantage may result from the selection of the proper brand of standard and high-early-strength portland cement for use in the concrete on every important construction project. Although the high-early-strength cements gave higher strength of concrete than did standard portland cement, the durability of concrete from intermediate and rich mixes was practically the same for the two types of cement.

The problem of volume changes in concrete due to variation in moisture conditions has not been fully solved as yet. In order to study the effect of some of the fundamental causes of this volume change, an investigation is at present under way: 150 3x6-in. concrete cylinders are being subjected to volume-change observations, and such factors as cement content, paste content, brand and type of cement, length of moist-curing, and type of fine and coarse aggregate are studied. The results bring out some very interesting relations, which will soon be presented to the engineering profession.

INGE LYSE,
Research Associate Professor of Engineering Materials.

FIG. 5—WIRE ROPE in a loading rig designed to yield information on stresses in the portion around a sheave.

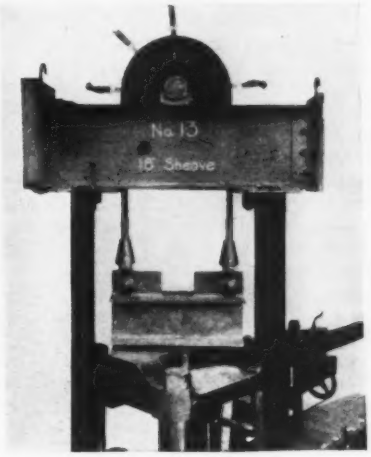
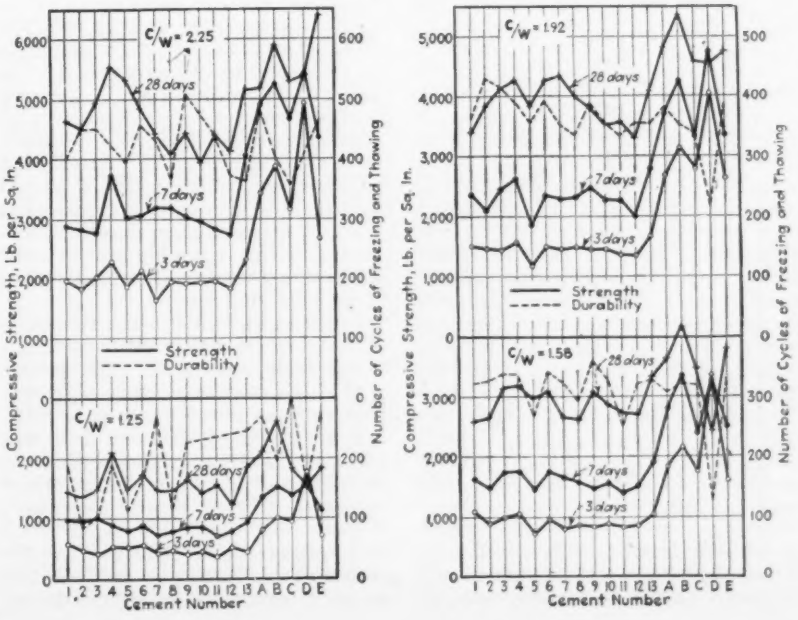


FIG. 6—STRENGTH AND DURABILITY of four types of concrete made with thirteen standard and five high-early-strength portland cements.


C/W = 2.25
C/W = 1.92
C/W = 1.25
C/W = 1.58
28 days
7 days
3 days
Strength
Durability
Compressive Strength, Lb. per Sq. In.
Number of Cycles of Freezing and Thawing
Cement Number
1 2 3 4 5 6 7 8 9 10 11 12 13 A B C D E

AN ENGINEER'S RECOLLECTIONS

By JOHN F. STEVENS

Consulting Engineer
Baltimore, Md.

·IV·

Winter Work on the South Shore Railroad

Working against time to get the contractors in before the spring break-up, handicapped by deep snow and poor transport facilities—Wolves tree the "old man"

EARLY in the spring of 1886, I was complimented by Mr. Whittemore, chief engineer of the Chicago, Milwaukee and St. Paul R.R., when he asked me to take charge of the construction of the 90-mile line from Sioux City to Manila, Iowa, which I had located four years previously. I accepted his offer with alacrity, for a field engineer in those days was much like a bear; if he hadn't laid on a reasonable amount of fat during the summer season, he had hard work to hibernate through the winter. Nothing of especial moment occurred during the progress of this work, in fact the experience was rather tame to me after my years in the mountains. However, nothing is insignificant in engineering, and I gave my best efforts to the solution of the various problems that came up, and on the whole was well satisfied with the results of the season's work.

When the work of grading and bridging the line was completed and there was no prospect of employment with the "Milwaukee" through the coming winter, I was offered, and accepted, a position in northern Michigan. A syndicate had been formed to create a railway (the Duluth, South Shore & Atlantic) from Sault Ste. Marie westward through the northern part of the peninsula and northern Wisconsin to Duluth, at the head of Lake Superior. The syndicate had bought the old railroad, which extended from Marquette to the Straits of Mackinaw at St. Ignace; also the old line from Marquette westward through the iron range and northwest through the Lake Superior copper region to Houghton. These acquisitions left 40 miles to be built from Sault Ste. Marie westward, and about 220 miles westward from Nestoria, Mich., to Iron River. From Iron River to Duluth the South Shore R.R. ran over the Northern Pacific Ry. tracks. After my time the South Shore built its own line from Iron River to Duluth. Later on it connected again with the Northern Pacific somewhere near, or at, Ashland and now uses that line to Duluth, abandoning its own line.

My salary was fixed at $250 per month, which was twice what I had ever received before, and I was quite overwhelmed with its size until I realized the responsibilities which I had assumed, which were great, as will be seen. I closed up my work in Iowa with credit and went to Marquette, which city was headquarters for me during the next two years, my family joining me there in a few weeks.

In charge of field work

I found that the chief engineer, J. A. Latcha, had established his office in Marquette and had placed several parties in the field, which were working on location surveys. Mr. Latcha was an experienced engineer, having been, in addition to holding other important positions, chief engineer of the Nickel Plate Railroad during its location and construction. He was perfectly contented and well satisfied to stay all the time in Marquette, and let me, the principal assistant engineer, attend to all the active work connected with the locating and constructing of the new lines, deferring to my judgment in all outside matters connected with them, as he never saw a foot of the road or of the country through which it passed until he went over it on a special train a month or more after its completion. He was a very agreeable man to work with, and our two years' association was harmonious in every way.

I took up the new work in the month of December of a very cold winter, accompanied by deep snow. The greater part of the country through which the lines were projected was a wilderness. For one stretch of 100 miles there was not even a house, much less anything in the nature of a settlement; and there was only one road, the old Ontonagon military road which ran north clear across that part of Michigan to the settlement of Ontonagon on Lake Superior, a road which, owing to years of disuse, had become impassable. Snow had already fallen, and would average at least 3 ft. in depth over that section of the country. With the short days of winter, the prospect of completing the location of the line that arctic season was not very encouraging.

Working against time

Owing to the lack of roads and the swampy nature of much of the country, it was a vital necessity that the contractors should get their plant camps and a large amount of supplies on the ground before the spring break-up, and this they could not do until the final location of the line indicated where the camps should be placed. I found my work cut out, and it proved to be a strenuous winter indeed.

The old military road, of which mention has been made, was built prior to 1837, while Michigan was yet a territory. The parties who built it for the government received as compensation a tract of timberland through which our located railway line passed for some 15 miles. In checking up our right-of-way lines, I was struck with the correctness with which the subdivision land lines had been established, and on digging into history I found that W. A. Burt, of solar compass memory, had personally made the surveys. He certainly did fine, honest work, comparable with that which another surveyor, George Washington, did for Lord Fairfax in the wilds of western Virginia.

Changes in parties and plans

All of my line traveling was done on snowshoes, in the operation of which I was fairly expert. My first work was to go over the country through which the line was to be built, and decide in general where the location should be. I made some very radical changes in the plans and methods that were being pursued by the parties then in the field, and also changes in, and additions to the personnel of the engineers; I also

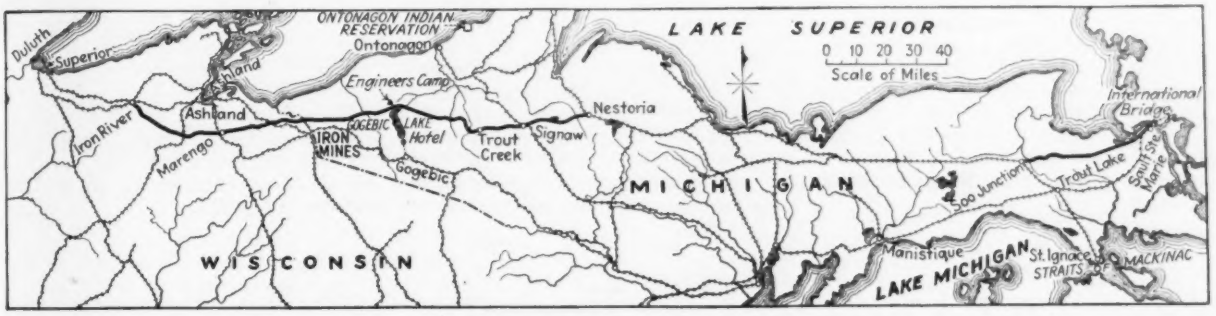
organized and placed several more parties on the work. The problem of keeping the corps supplied with food in that wilderness was not an easy one, much of the transport of supplies being done by packing on men's backs, or by toboggans, and in the case of some of the most isolated camps it was done by dog teams. As I had ten large parties in the field, the organization of the commissary had to be, and was, very effective. There never was any shortage of food or other necessities at any camp during the winter.

I spent practically the entire winter on snowshoes, traveling from one party to the next, sometimes with one man accompanying me, but generally alone. The Marquette office saw me but seldom, and then only for a day or two. I soon had the engineers lined up and the surveys progressing rapidly in spite of the handicaps, not the least of which was the necessity of digging through several feet of snow to set every stake. Before the snow began to melt and the swamps had thawed so as to become impassable for teams, the greater part of the final location of the line had been made, the contractors' camps, plant and supplies were ready, and in a number of places the work was in progress. I felt amply repaid for my efforts, for as a matter of fact, I enjoyed the hard winter's experience.

Treed by wolves

The life itself was not humdrum, and there were occasional diversions that broke the monotony. As usual, in sections where deer were fairly plentiful there were timber wolves roaming the wilderness. Late one afternoon while traveling alone, five of them put me up a tree in a swamp a few miles east of what is now Soo Junction. There was a comparatively light depth of snow and my snowshoes were slung on my back. I did a lot of not particularly cheerful forecasting for an hour or so up in that tree, but before darkness began to gather, for some occult reason, the wolves went off as suddenly as they came. They probably sensed some danger which only the marvelous instinct of wild creatures can detect. Wasting no time in speculation about their motives as soon as they were out of sight, I dropped out of the tree and left in high gear in another direction, charting my course by handy clumps of trees, and soon reached the comparative safety of the railroad, which I followed to the first place that offered a shelter for the night.

Another time I had come up by rail and left the train about 5 miles south of Lake Gogebec, which was about 12 miles long. I had a camp of engineers at the north end of the lake whom I wanted to visit. I went to a so-called summer resort hotel at the foot of the lake for the night. Early the next morning I started on foot with a light pack for the camp, in the face of warnings that the lake was impassable. Much of the snow on the lake had been blown away, and with a few fairly warm days the thick ice had become flooded, then a cold night or two had frozen the surface water, but not entirely through. The ice held me all right for awhile, and then I began to break through into from two to six inches of water, and my foot and leg coverings became solid ice. Just how I managed to slog and splash through that last ten miles to camp I do not know, but I suppose that nerve, and the providence that is reputed to care for children and fools were the answers. I reached camp about dark, all in; but a thawing out, food and a night's rest made me as cocky as ever.



CONSTRUCTION of a through railroad line from Sault Ste. Marie to Duluth was undertaken in 1886. It called for new work from the international bridge at Sault Ste. Marie to Soo Junction and from Nestoria to Iron River, as indicated in heavy lines. From Iron River to Duluth the South Shore R.R. operated over Northern Pacific Ry. tracks.

Construction begun

On the approach of summer the forces were increased as fast as laborers could be secured, most of them from Chicago, where the demand was heavy. As the work of grading was generally light in character, good progress was made. With one exception we had a satisfactory lot of contractors. This exception was a firm from New York City, which had neither the proper plant nor experience in that class of work, nor, as it eventuated, sufficient capital. But by the help of the railroad company it managed to finish its contract without holding up the track-laying.

The road was one that as an engineer I did not take any great pride in building. It was understood that one basic, if not the principal, reason for building it was to make money for some members of the syndicate, and I was so advised when I took charge. I can frankly say that I thoroughly performed the duty as so laid before me. After the road was completed the chief engineer told me that I had enabled a profit to be made of about a million dollars more than had been estimated before I took charge of its location and construction.

I received thanks for what I had done, but only knew by hearsay of any part of the million. But the road was amply good enough for all the business it could get.

Taken over by the C.P.R.

The work of grading and bridging went on during 1887, and was completed, track laid and sand-ballasted, telegraph line and buildings erected, so that by the fall of 1888 the road was ready to be turned over to the operating department. But for a couple of months it looked as though the road would have to lie idle or operate itself, as we of the construction department could not get rid of it. Finally the Canadian Pacific Ry., which connected with it over the international bridge at Sault Ste. Marie, took it over, Sir William Van Horne, president, and others of that company's officials making a trip over the new road by special train, the first passenger train to run over the entire main line of the Duluth South Shore and Atlantic Ry., as the consolidation was named. Mr. Latcha, the chief engineer under whom I served, was on the special, and at that time got his first look at the new road or of any part of it.

As a little interlude introduced between the hours of track-laying and ballasting, one of my gangs of Italian laborers took a violent dislike to me because I had ordered a contractor to burn the carcass of a mule that had died from natural causes, they claiming it for food. Watching their chance, a bunch of them chased me a half mile or so down the track, flourishing knives and clubs with wild yells. But I was too fleet-footed for them and reached safety easily. Some of the irreverent

thought that it was a good joke on the "old man" for presuming to restrict the dietary of the men.

Legal difficulties arise

As the road went into operation I was asked to remain with it as superintendent, but I did not care to pass out of engineering, so I closed up my connection with the company and went home to Minneapolis. At least I thought that I had closed it up, but I had not gotten through with the legal entanglements. The firm of contractors from New York, which had not done very well, refused to make a final settlement on the basis of my estimate, and sued for half a million dollars more than the estimate allowed them. One item of their claim was "general oppression" on my part, which being interpreted, meant that I had kept them somewhere within hailing distance of the specifications, including classification of materials.

The case was tried the following year at Detroit, and it lasted for several months, with an imposing array of legal talent. I was in attendance for six weeks as principal witness for the company, and the result of the contest was a verdict for the contractors of some $60,000, which was rather a hollow victory for them, as it included $50,000 of retained percentage, which they could have had at any time on making final settlement.

The outcome of the suit was an emphatic endorsement of the correctness of my judgment in the conduct of the work and the justice of my estimates. The jury was made up of business men and was rather above the average in intelligence of juries in such cases, but they had a lot to learn of technicalities. After at least twenty witnesses had testified, one of the jurors, with the permission of the judge asked me when on the stand if a berme was an instrument that we used in cross-sectioning.

Classed as a genius

A long time afterward when I was chief engineer of the Great Northern, I met the then general manager of the "South Shore Ry." in St. Paul. He was a sarcastic sort of a man whom I had never before chanced to meet. On being introduced to him he said that he had often wished to meet me, as I was undoubtedly a genius. I immediately braced up and began to look important, when he added, "Yes, a man who could build several hundred miles of railroad and dodge all of the business of the country must be a genius."

After the timber along the line had been cut, there was little local business from the few small farming communities that gradually came into existence. The road passed along some miles north of the Gogebic iron range, where the mines were putting out an immense tonnage of ore for shipment to lake ports. Later, branch lines were built to some of these mines, but the road has never been a serious competitor to the Northwestern, which handled the bulk of the ore to its docks at Ashland, Wis. Its chief business was, and is, what it could get through its affiliation with the Canadian Pacific.

While I was in the employ of the syndicate, the Russian government sent two of its engineers to study the American system of railroads. I met them several times and had an opportunity to offer them some small courtesies. They were very agreeable gentlemen to meet, as the high-class Russian always is, and they never fail to reciprocate any such attentions. The next year I received an invitation from their government to visit Russia and inspect its railways, all my expenses to be paid by it. I was sorely tempted to accept the invitation, but I was unable to do so. Thirty years later I had an opportunity to inspect a lot of Russia's railways under vastly different conditions, during my six years' service in the Great War.

This article is the fourth of a series of recollections by John F. Stevens. The previous ones were published in ENR, March 21, p. 412; March 28, p. 450; and April 11, p. 521. —*Editor.*

Garbage Disposal at Fresno Placed on Efficient Basis

Truck bodies in which collections are made are low enough to allow loading from the street—Trucks unloaded by pulling back a movable diaphragm—Dragline operator, who balances cut and cover, is only man kept at fill

FRESNO, CALIF., a city of the San Joaquin Valley with a population of about 60,000, recently took over from a private company the collection and disposal of garbage and household refuse. New automotive equipment was purchased, and a sanitary fill was started along lines that are believed to involve a minimum of expense consistent with no nuisance features. The total cost of disposal at the fill by methods described in the following paragraphs is reported as only 25c. per ton.

When the city took over the disposal of garbage and other refuse on Oct. 15, 1934, city officials were prepared, as the result of previous detailed study of the problem, with a plan for economical operation. Fundamentals in the plan are: (1) that low-body trucks increase the number of collections per man; and (2) an effective system for unloading the trucks at the sanitary fill makes it unnecessary to provide a dumping mechanism on each of the collection trucks.

Special bodies were built on 1½-ton truck chassis, and hinged sides or "gates" were arranged to swing down while the first part of the load is being gathered. Later, when the full capacity of the truck is required, these gates are fastened in a raised position. On this plan the height to which the first part of the load has to be lifted by the collectors is only 54 in. With the sides up, a lift of 66 in. is required. With this design it was possible to provide truck bodies with a capacity of 12 cu.yd. As Fresno garbage weighs about 450 lb. per cu.yd., this body capacity accommodates a load of 2½ to 3 tons, which is not considered excessive for the trucks.

Fresno city officials place emphasis on these low bodies, because they are in striking contrast to the common type of garbage truck in which as many as five steps must be taken by the collector to dump even his first load into the truck. With the Fresno truck-body design even the last of a 3-ton load can be dumped into the truck by a collector standing on the street. This ease of loading, of course, greatly increases the number of collections daily per man. Twelve trucks of this type are in service.

A very careful time study of garbage-collection routes (made partly before and partly after taking over the work by the city) showed requirements in different parts of the city to vary widely. Moreover, collectors assigned to a certain district could be expected always to take the entire time allotted to make the collections. In some districts it was found that 69 collections per hour were made by a two-man crew, and elsewhere as low as 35. Careful redistricting with a view to assigning each truck (manned by driver and one helper) to an area just large enough so that continual and conscientious effort would be necessary to cover the route within the regular working day saved considerable time previously used in making collections.

FIG. 1—LOW-BODY TRUCK used for garbage collection in Fresno, Calif. Note side gates that are swung down until truck is partly loaded.

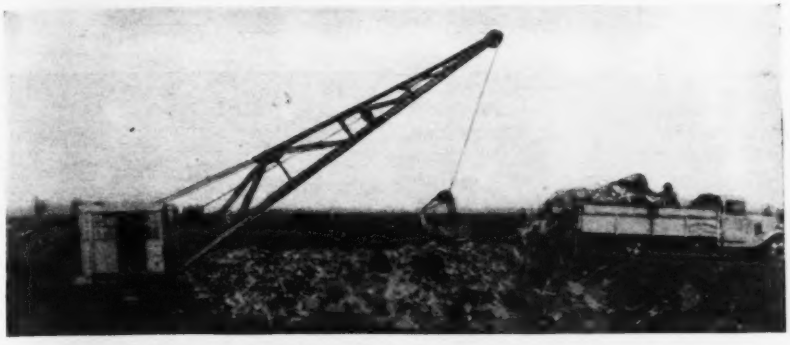


FIG. 2—DRAGLINE unloading garbage truck by pulling back the diaphragm or drag-board placed in the truck body before loading.

The redistricting study showed that the city could be divided into 48 districts, each of which could be covered effectively in eight hours or possibly a little less when the men knew the routes. At first, the men spent 10½ hours in covering their districts, but after a few weeks' experience they were able in all instances to reduce the time so that eight hours would suffice. If the collectors can complete their routes by fast work in less than eight hours, the time saved is their own. For the collectors only high-grade, white American labor is used; the driver in charge of the route is paid 67½c. per hour and the helper 61c. With weekly and semi-weekly collections on the basis of a 6-day week the 48 districts divide up evenly into eight zones.

Sanitary-fill method

The site selected for the sanitary fill is on city property near the sewage farm about 7 miles outside the city limits, where the average haul for the garbage trucks is about 9½ miles. A full-revolving dragline stationed at the fill has a 40-ft. boom and a ½-cu.yd. bucket. This machine performs a three-fold function by (1) excavating a trench 2½ ft. deep into which the garbage is dumped, (2) unloading the trucks into that trench, and then (3) covering over the dumped garbage with a layer of earth 1½ to 2 ft. thick.

The program for these operations is as follows: Before the collector loads garbage into a truck, a drag-board with chains suitably attached is placed in the forward end, and the chains are laid on the bed of the truck so that the terminal ring in which they join lies at the rear end, conveniently accessible when the tail gate is opened. When the loaded truck backs up to the edge of the trench, the tail gate is dropped, the dragline bucket is attached to the ring in the chains, and the load is discharged by pulling the drag-board to the rear. Any spreading necessary to distribute the refuse in the trench to uniform depth is done by the dragline, which then places the earth covering, using for this purpose earth excavated by the same bucket from an adjoining trench site. The digging is done only as earthfill is required, cut-and-cover balance for each linear-foot of trench and covered fill, so a new trench is excavated only as fast as the fill progresses.

The trenches are excavated 2½ ft. deep and 24 ft. wide. The garbage fill placed in each trench is 6 to 8 ft. thick, and on this a 2-ft. earth layer is then placed, making a total of 8- to 10-ft. initial depth of fill. Initial settlement and weight of the earth covering usually compact this initial depth to 6 ft. or a little more. By leaving a cross-wall every 200 ft. the trench becomes a series of cells, each cell representing about two weeks of garbage deliveries. In other words, approximately 200 cu.yd. per day is delivered to the fill, and a day's operations ordinarily will fill a 33-ft. length of the trench. With this plan of operation, only one man is required at the fill—i.e., the dragline operator, whose salary is $160 per month, constitutes the only labor charge at the fill.

The minimum charge to householders is based on a 30-gal. can and is 50c. per month for a single collection per week. For two collections per week the charge is 85c. per month, and for larger containers the monthly rate increases 3c. for each additional 10 gal. in capacity per collection. Fresno garbage contains much paper, only about 10 per cent is table refuse, and 90 per cent is rubbish.

The tract that the city is using for the sanitary fill is estimated to have sufficient area to meet fill requirement for many years; only about 5 acres of land is estimated to be required per year. City officials believe that in time the waste first placed will have been completely decomposed, and the area could be used again in the same manner as at first. No odors have developed, it is reported, and no sprays are used. Observations on rate of settlement of the fill are being made.

The Public Works Department of the city of Fresno worked out the design of the trucks, developed the plan of disposal and operates the sanitary fill. The department is headed by Jean Vincenz, commissioner; Frank Rantsma is deputy commissioner in charge of operations.

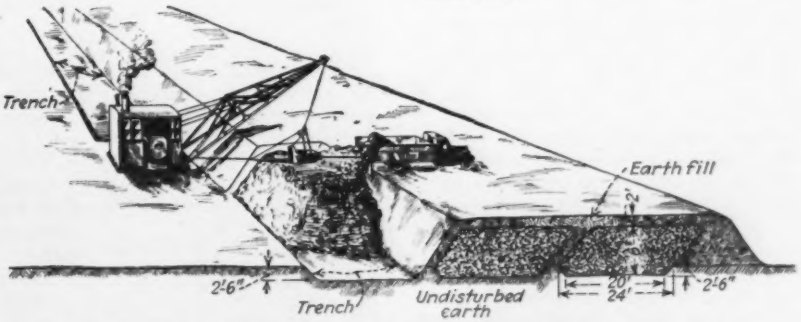


FIG. 3—CROSS-SECTION OF THE FILL made by garbage covered with earth. Trench cut and garbage cover are made to balance.

Permeable Groins of Concrete Check Beach Erosion

Beach and bluff at Cudahy, Wis., on Lake Michigan, protected by drain back of crest to intercept surface water, drains tapping face of bluff for underground water and permeable outshore groins to build up the beach

By E. A. Howard
Supervising Engineer, Regional Planning Dept., Milwaukee, Wis.

RECESSION of the high steep bluff along the shore of Lake Michigan at Sheridan Park, Cudahy, Wis., as a result of erosion had been going on at an average rate of 2 ft. annually until protective measures were initiated in 1933. Construction of the protection was completed late in 1934 with CCC labor. It was found that three agencies were factors in the erosion: surface drainage, underground water and wave action at the bottom of the bluff. Sloping the bluff away from the top edge, draining out the subterranean water and building permeable concrete-slab groins along the beach are the means that were used to control these actions and build up a usable sandy beach.

Much of the west shore of Lake Michigan is characterized by a steep bluff, 50 to more than 100 ft. high. Recession of the bluff is constantly taking place through erosion, slippage, or, more especially, by reason of wave action at the bottom of the bluff. At Sheridan Park, one unit of the Milwaukee County park system, the lake bluff is 100 ft. high and very steep. Here destruction by surface erosion and subterranean water is nearly constant, but that resulting from wave action is periodic and is by far the most vicious, the greatest damage occurring during high lake stages and heavy storms.

Drainage provided

Surface erosion is caused by precipitation directly upon the slope of the bluff and, more especially, where deep gullies have developed, by surface water gathering upon lands adjacent to the top of the bank and running down the face of the bluff. To control surface erosion, the terrain at the top of the bank was reshaped so that the surface water is drained away *from* rather than toward the bluff. The water is directed to catchbasins, where it is carried away through a storm sewer installed as a part of the project. The face of the bluff is being landscaped and planted so that the velocity of any water that may fall directly upon the face will be retarded and the eroding action thus reduced.

Subterranean water is drained away by tile lines constructed in the face of the bluff, leading directly from the sand pockets or sand strata down the bank to the water's edge. Subterranean water is also being intercepted by a deep cutoff drain placed 100 ft. inland from the top edge of the bluff at a depth of 20 ft. or more. The trench is backfilled with porous material so as to intercept any seepage water that may percolate through the strata above the drain.

With the soil conditions found at Sheridan Park, interception of subterranean water is important. The material in the bluff ranges from an extremely fine sand to a heavy clay. The face of the bluff is much stratified, and there are extensive pockets of the finest sand. When this sand become saturated, it flows like water and allows the pressure of the overburden to squeeze the sand out of the pocket; the earth above then collapses, and the entire mass slides down the face of the bluff. Such slides may occur on a small scale, but sometimes thousands of tons of

FIG. 1—SHERIDAN PARK BLUFF, 100 ft. high, protected by eleven permeable groins between which a sandy beach is being built up.

FIG. 2—CASTING YARD for groin segments. Mixer is at left. Crane in background handles segments from casting platform to curing piles.

FIG. 3—PLACING SEGMENTS in groin with crane. Structure is doweled together with bars extending upward from sill blocks. Note capping blocks at left.

earth, together with trees and shrubs, are transported from the top of the bank to the bottom.

Protection from wave action

The greatest menace to a stable bluff is the cutting action of the waves at the base. If the material that washes down the bank by surface erosion or is carried down the bank through slides by reason of the subterranean water conditions were allowed to remain at the bottom of the bluff, an angle of repose would soon be established, and in a short time a growth of trees and vegetation would hold the bank in place. The lake is relentless, however, and through the continued cutting action of the waves at the bottom of the bluff, especially during northeast storms that occur when the lake level is high, the land that slides down the bank is carried away. Several years ago at Sheridan Park a bath house was built on the shore at the bottom of the bluff, and the bluff itself was planted with trees. Today the bath house is gone, destroyed by caves and slides, and the trees have slid into the lake. Before any permanent improvement of the bluff itself could be undertaken, it was therefore necessary to afford protection to the bottom of the bluff.

Protection has been provided by a system of groins, designed and constructed to break up the scouring and eroding waves as they come rolling in at an angle to the shore, and to cause the sand and silt carried in suspension to precipitate, thereby adding such deposits to the beach. Eleven groins (Fig. 1) of permeable type, 200 ft. apart, have been built, extending from the bottom of the bluff to 200 ft. beyond the shore line. The theory and construction of the permeable groins are the most interesting parts of the entire project.

First consideration was given to the construction of a breakwater located some distance offshore and paralleling the beach. Unquestionably this type of construction would be effective in preventing erosion at the base of the bluff. However, funds and equipment available with the CCC were not sufficient to consider building this type of breakwater, and attention was therefore directed toward a different type of construction, using materials such as sand and gravel found near the north end of the beach. Furthermore, groins were decided upon in preference to a breakwater because of the possibility of improving the beach by the accretion of sand that might be expected.

Theory of groins

There is nothing new about the use of groins in shore-protection work; they have been used along the Atlantic seaboard, on the Great Lakes and in European countries. However, so far as we know, the idea of progressive permeability in the construction of the groin is comparatively new and has been developed by Sidney M. Wood, of Lake Bluff, Ill., who contributed his advice in the building of the groins at Sheridan Park. The theory of progressive or increasing permeability advanced by Mr. Wood means that the permeability of the groin to the flow of water through the structure shall increase with the distance out from the shore. The shore section is almost solid and allows practically no water to flow through, whereas the lake end permits a free flow of water; the openings in the intermediate sections increase in size as the distance from the shore increases.

Experience with solid groins in the vicinity of Milwaukee over a period of years has shown that ordinarily materials will be deposited on the north side of the groin, while little deposit occurs on the south of the groin, and there may be actual scour. This fact is noticeably apparent at South Milwaukee, where 40 years ago the government began the development of a harbor and built a breakwater 1,000 ft. long extending into the lake at right-angles to the shore. An accretion of 20 acres has resulted to the north of the breakwater, but to the south there has been loss of beach for a length of a half mile.

With a permeable groin, the free and extensive flow of water through the groin is claimed to deposit material more evenly on both sides of the structure. This claim is supported by observation of the action of the first unit at Sheridan Park, built in the fall of 1933.

Groin construction

Near the north end of Sheridan Park there was a deposit of sand and gravel

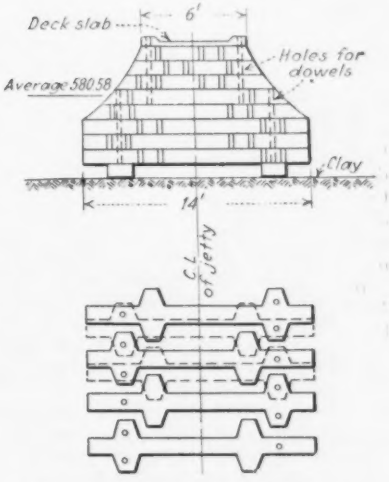


FIG. 4—BLOCK ARRANGEMENT employed in building up permeable groin of precast concrete members.

suitable for concrete if crushed and washed. A crusher was rented, and in a month several thousands yards of gravel were crushed. A small vibrating screen and pump were purchased, and the crushed aggregate was run over the screen and washed, being separated into fine and coarse aggregate. The concrete aggregate was then transferred in small cars pushed by hand along an industrial railroad to the casting yard (Fig. 2), where the concrete slabs and segments were poured. Each precast unit weighed from 2,500 to 6,000 lb. Enough reinforcing steel was used so that the units would not break when lifted or after being set in place. As soon as the concrete segments were sufficiently set, they were moved from the casting platform by a crane and allowed to cure for several days. After curing, they were transported on cars, pulled by a small tractor along an industrial railroad track to the location of the groin, and put in place by the crane (Fig. 3). The design of the

groin was such that the individual segments or units were tied together by steel rods extending vertically upward from the sill blocks (Fig. 4).

Work was begun in the summer of 1933 and completed in the fall of 1934. Eleven groins were constructed, four of which were built in the fall of 1933 and were observed during the winter and summer of 1934. Experience during the past year and a half indicates that the groins are sufficiently strong to withstand the buffeting of the ice in winter-time and the storms of other seasons. In the early part of December, 1934, the most severe storm on Lake Michigan since 1929 did not damage any of the groins and demonstrated that this type of construction was effective in preventing erosion at the bottom of the bluff.

Formerly the immediate shore at the bottom of the bluff was rocky and uninviting. Sand deposits formed during the past year have created a much improved beach. In 1934, for the first time in years, the beach at Sheridan Park was used by the public for recreation and for swimming.

The camp at Sheridan Park is one of the National Park Service CCC camps. The work and conduct of the CCC enrollees under the auspices of this department have been excellent. The work has been closely inspected by Carter Jenkins, district inspector of the National Park Service. The superintendent in charge of field construction is George W. Rauch. Plans were prepared and general supervision of the project was under the direction of the Milwaukee County Regional Planning Department, the technical staff of the Milwaukee County Park Commission.

Engineering in Foreign Countries

Accounts taken from the foreign-language periodicals of important activities in engineering research, design and construction being carried on beyond the United States

TO GIVE the readers of *Engineering News-Record* quick glimpses of engineering activities beyond the United States, these short abstracts of articles and papers published in languages other than English are presented monthly. In these abstracts no attempt is made at a compendium of foreign-language articles, but selection is made from articles that emphasize some procedure or invention in engineering practice that has general interest or usefulness.

Previous groups of these abstracts from foreign periodicals have been published in *Engineering News-Record* of Jan. 31, Feb. 21 and March 28, 1935.

Needle dam prevents harbor pollution

The great water-power development on the Göta-älv River in southwestern Sweden, described by Von P. Wittrock in *Bauingenieur* of May and June, 1934, brought about a rather unusual situation at the mouth of the river. It was feared that storage in Wener Lake (about 60 miles upstream), required for the water-power project, would greatly diminish the river flow and cause pollution in the port of Göteborg. It was also feared that the greatly reduced river discharge would allow the tides to carry salt water much farther upstream and thus contaminate the water supply of the city of Göteborg, which is derived from the same river.

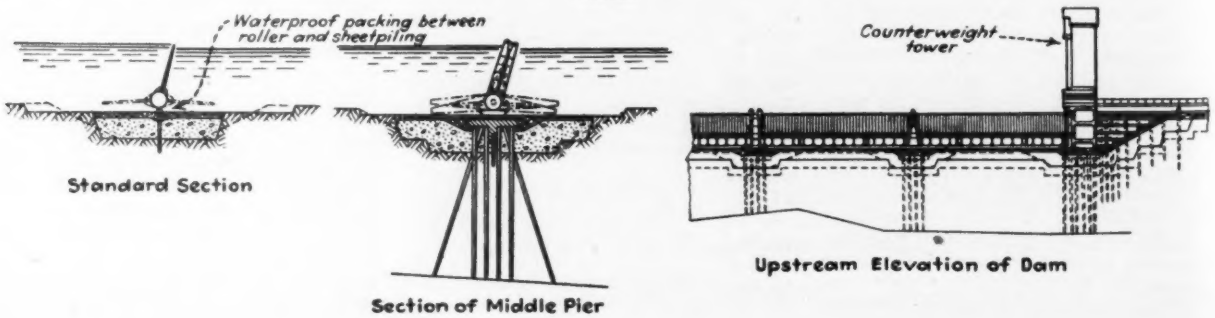
To prevent these troubles, it was decided to take advantage of the fact that about 10 miles above Göteborg the Göt-älv branches out into two channels: the Göteborgsgrenen flowing seaward past Göteborg, and Nordre älv discharging at a point about 7 miles northwest of the city. A movable needle dam of original design was built across the Nordre älv to force the entire flow of the river into and through the Göteborgsgrenen, which normally carried only 25 per cent of the Göta-älv discharge, thus eliminating the serious hazards of reduced river flow past Göteborg.

The needle dam, which is about 25 ft. high and 492 ft. long, is divided into four shutters, about 123 ft. in span, which can be rotated 180 deg. in a vertical plane. The wood needles, which are about 20 ft. long, are set in four rotating welded steel plate rollers, 6.56 ft. in diameter, laid along the bottom sill and supported on bearings resting on concrete slabs carried on wood piles.

The shutters are operated in pairs by counterweights consisting of water tanks running up and down inside two welded steel towers at the dam abutments, rising to a height of about 100 ft. above river bottom. The shutters are raised by pumping water into the counterweight tanks and are laid down by emptying the tanks. When the counterweight tanks are full, the dam will support an 8-in. head of water on either side. The shutters can be set to respond automatically to water-level differences exceeding a predetermined limit.

The reinforced-concrete substructures of the operating towers, which were precast at a drydock, were fitted with a false bottom and were floated to the site, as were also the steel plate rollers that had been fabricated at a near-by wharf.

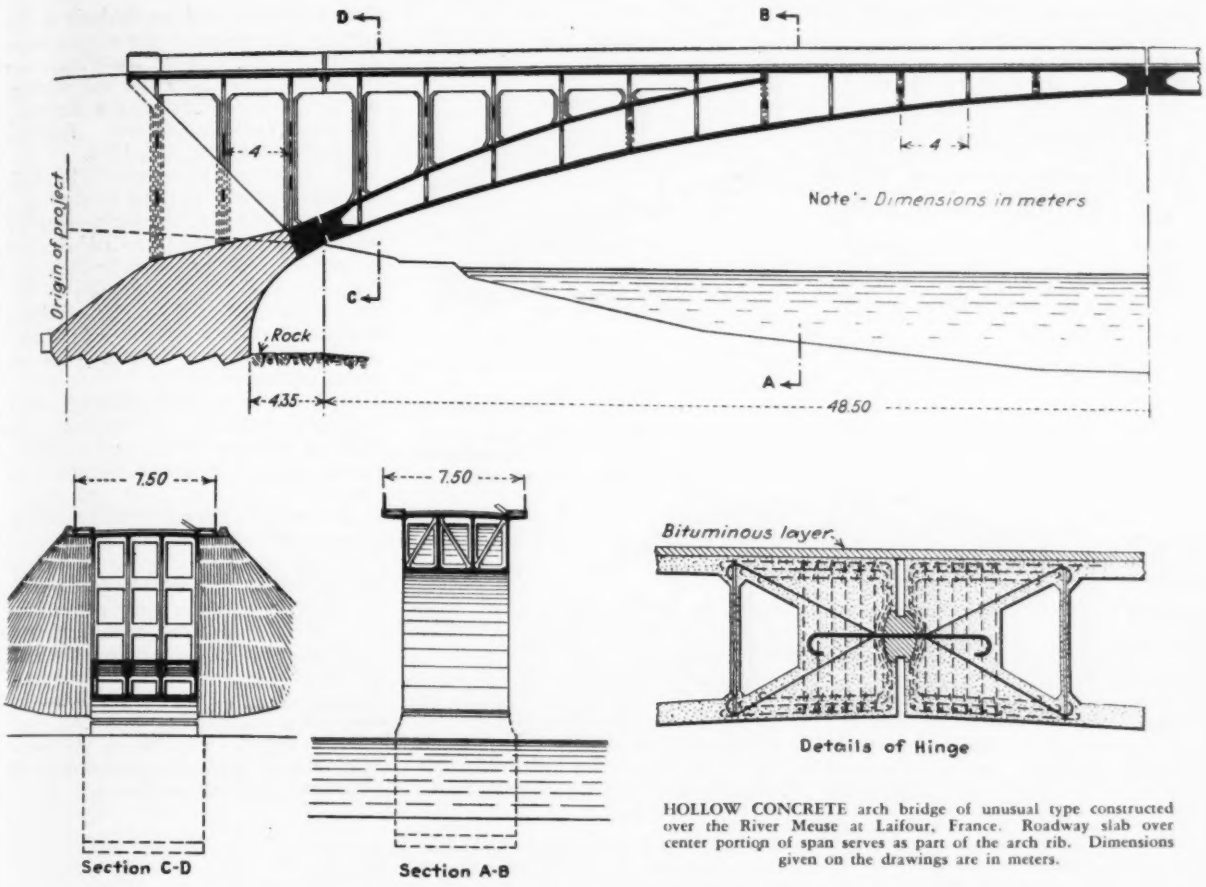
MOVABLE DAM operated by counterweights, which has been constructed to prevent pollution of the Göta-älv River from low water and sea water at Göteborg, Sweden.



Moleskin cloth for waterproofing

In a paper read before the French Academy of Sciences, reprinted in *Le Génie Civil*, Dec. 1, 1934, G. Menier tells of his experience with commercial moleskin cloth used as a waterproof membrane for cofferdams, needle dams and similar hydraulic structures.

Moleskin cloth, which is commercially available in two thicknesses, was used by Mr. Menier with great success in 1914



HOLLOW CONCRETE arch bridge of unusual type constructed over the River Meuse at Laifour, France. Roadway slab over center portion of span serves as part of the arch rib. Dimensions given on the drawings are in meters.

for waterproofing a cofferdam over 18 ft. high, which was built in connection with the replacement of a hydraulic turbine 23 ft. in diameter. Only one line of wood sheetpiling was driven with indifferent care, and the bolts of moleskin cloth were unrolled over its outer side, downward, by means of heavy cast-iron rods attached to the bottom edge of the cloth. When the cofferdam was unwatered, the moleskin cloth was pressed against the sheetpiling by the surrounding water and prevented leakage into the cofferdam.

During the recent drought, thin moleskin cloth was used, upon Mr. Menier's recommendation, by the French Service de la Navigation to waterproof a leaky needle dam at Noisiel, on the Marne. The job was a complete success, and no leakage has been observed for four months.

Pieces of thin moleskin cloth were tested by Mr. Menier by stretching them over an aperture having a constant height of 16 in. and a width that could be varied from 0 to about 4 in. The pressures required to tear the stretched moleskin pieces are given in the following table.

Width of Aperture, In.	Tearing Pressure, Lb. Per Sq. In.	Corresponding Head of Water Ft.
0.4	100	231
0.8	92	213
1.2	64	147
1.6	57	131
2.0	43	99
3.0	28	65
3.9	14	32

Moleskin cloth was also used with success in preventing leakage through flashboards on crests of dams.

The cost is alleged to be comparatively insignificant even when the moleskin cloth cannot be salvaged for use on the next job.

Hollow concrete arch bridges

The recently completed hollow concrete arch highway bridge over the Meuse at Laifour, France, is described by M. Cayla in *Le Génie Civil* of Dec. 29, 1934, and in *Travaux* of December, 1934. The total length of this bridge is 412 ft., and its width, including two sidewalks, is 24.6 ft. It consists principally of one three-hinge, three-compartment hollow arch, 318 ft. in span, with a rise of 29.5 ft.

The outstanding feature of the hollow arch is this: in its middle portion, 148 ft. long, the bridge floor is utilized as a straight archback for the entire width of the soffit, which is 18.7 ft. The bridge floor and soffit are strongly braced together to act as a monolithic arch segment. For the rest of its length the arch is provided with a normal curved back surmounted with a quadruple set of spandrel columns, spaced 13.1 ft. apart, which carry the bridge floor. In addition to economy and certain structural and construction advantages, this design resulted in a pleasing architectural appearance.

In the hinges, extending throughout the entire width of the arch, thrusts up to 134 tons per linear-foot are expected to occur. In accordance with the Freyssinet system of design, the hinges consist of a lens-shaped block of extra-rich mix (2.7 bbl. of cement per cu.yd.) set between two jaws of heavily reinforced rich concrete (1.8 bbl. per cu.yd.).

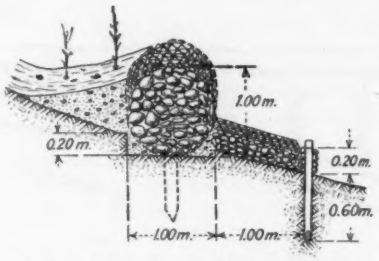
Stresses do not exceed 1,138 lb. per sq.in. in the arch and 1,422 lb. per sq.in. in the hinges.

The comparatively simple falsework, arch centering and forms were standardized as far as possible with the view of transporting them for use in the construction of a similar bridge having the same arch span but only 16.4 ft. wide, located at Anchamps, 2½ miles downstream. The total cost of the two bridges was about $106,000, which is only about $6.20 per sq.ft.

Soil-erosion control in Hungary

In a publication of the Hungarian Department of Agriculture, *Vizugyi Kozlemenyek, Muszaki Folyoirat*, July-September, 1934, A. Trummer describes Hungarian methods for checking of gullying and erosion of land. The more original of these methods are: (1) Construction of straight or curved plaited brushwood fences 1.5 to 4 ft. high, along hillside contours and across gullies,

which, by gathering debris on their upstream side, soon begin to act as effective, though cheap, check dams. For greater strength, two such brushwood fences are sometimes built, one closely back of the other and the space between them is filled with rock and gravel. (2) The construction of check dams consisting principally of cylindrical "logs" of rockfill, held together by a heavy wrapping of sturdy wire netting. Such logs, which are generally 3 to 4 ft. in diameter, are supplemented with stakes and sloping rockfill aprons held by a low brushwood fence.



CHECK DAM of stone bound into roll by wire netting used in work for erosion control in Hungary.

Russian tests of a high timber crib

Timber cribs as high as 40 ft. and more have recently been used by Soviet engineers, not only in temporary construction but also as permanent structures, notably as training and retaining walls for the White Sea Canal (Belomorstroy), which is alleged to be the longest artificial waterway in the world. Such high permanent cribs require careful designing not only for general stability but for strength and rgidity of the timber framework as well.

Lateral pressure on the crib walls was determined by the generalized Rankine formula: $P_w = P_s \tan^2 (45° - \phi/2)$, where P_w = lateral pressure per unit area of wall, P_s = downward pressure per unit area of cross-section, and ϕ = angle of repose of crib fill.

The value of P_s was to be determined by the accepted German formula developed by Prof. Jansen in 1895 for the design of grain elevators and siloes:

$$P_s = \frac{\gamma F}{k U}\left(1 - e^{-k\frac{U}{F}h}\right)$$

where γ = specific gravity of fill material, F = area of cross-section, U = perimeter of cross-section, e = Naperian logarithm base = 2.718, h = height of fill, and k is a constant = $P_w/P_s.f$, f being the coefficient of friction betwen fill and walls.

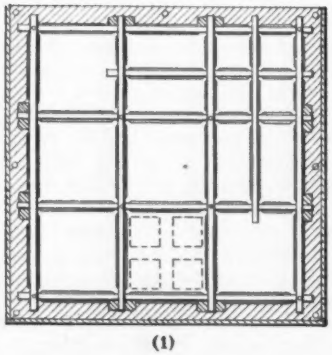
Large-scale tests that had to be made in order to check the applicability of the Jansen formula and particularly to determine the value of the all-important constant k for crib-fill materials, such as sand, gravel and loam, are reported on by N. M. Viatskikh in *Izvestiya Nauchno - Issledovatelskovo Institute Hydrotechniki*, Vol. XII, 1934.

The timber crib tested was 39.4 ft. high and consisted of nine equal vertical compartments, 6.9ft.x6.9ft. each, four of which were subdivided into half-size and quarter-size cells, as shown by the drawings. The physical properties of the three types of fill used—sand, sandy loam and gravel—were tested in a field laboratory established near the site of the experimental crib.

Pressures were determined by either of these two methods: (1) by measuring areas of imprints of Brinnel hardness-testing spheres, 10 mm. in diameter, set betwen two plates of boiler steel resting on the bottom of the crib; (2) by reading of mercury columns registering pressure on "diaphragm" box shown. A shallow concrete box at the bottom of the crib was covered with a rubber sheet about ¼ in. thick, which supported a solid timber platform. Water forced into the box filled the box and registered all pressures, subsequently applied on platform, by means of a mercury gage.

Deformations of crib walls and pressures on bottom of crib, indicated by 26 sets of observations, are shown.

TESTS OF TIMBER CRIB by Russian engineers to determine reliability of Jensen formula: (1) plan of test crib; (2) arrangement for crib tests; (3) deformation of crib walls; (4) values of k for gravel fill; (5) curves $P_s = f(h)$ for sand fill for compartment 1 and 5. $F = 3.5\ m^2$. $U = 7.5\ m$; (6) curves $P_s = f(h)$ for sandy loam fill for compartments 2 and 4. $F = 3.5\ m^2$, $U = 7.5\ m$.; (7) relation between k and maximum compressive stresses, for crib 12 m. (39.4 ft.) high, framed of timbers 22 cm. (8.6 in.) in diameter. Compartments: 2.10 m. × 2.10 m. $F = 3.5\ m^2$; $U = 7.5\ m$. Specific gravity of wood = 0.80.



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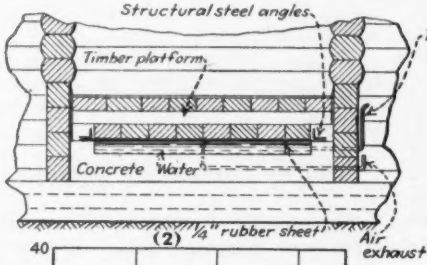

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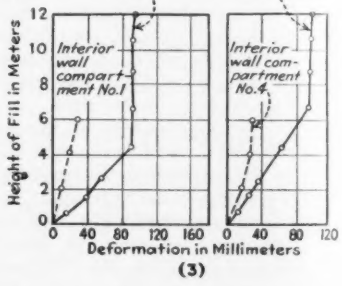
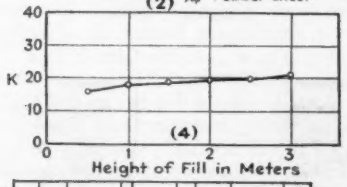

Exterior wall compartment No.1
Exterior wall compartment No.4
Interior wall compartment No.1
Interior wall compartment No.4
Height of Fill in Meters
Deformation in Millimeters

(3)



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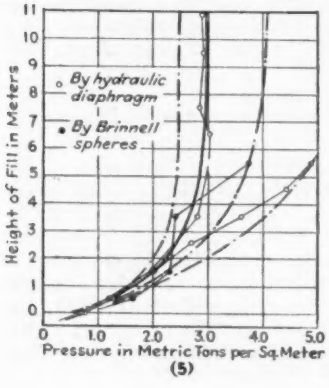

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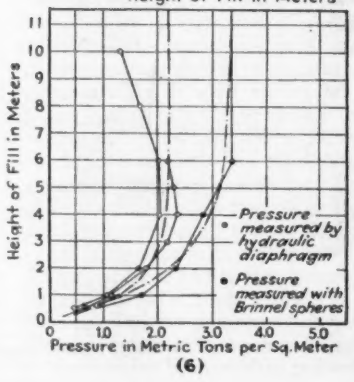
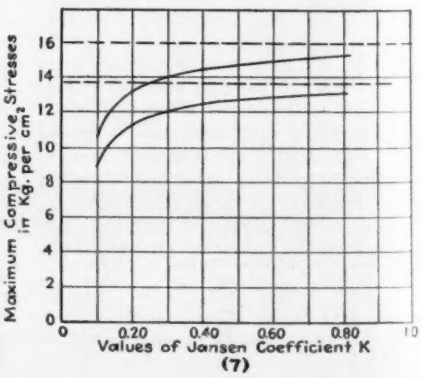

Pressure measured by hydraulic diaphragm
Pressure measured with Brinnel spheres
Height of Fill in Meters
Pressure in Metric Tons per Sq. Meter

(6)



(7)

The author concludes that the tests have justified the use of the Jansen formula in the design of high timber cribs. The following values for k are recommended:

	k (Indicated by Tests)	k (Recommended)
Gravel fill	0.20	0.20
Sand fill	0.13-0.26	0.30
Sandy loam fill ..	0.20-0.40	0.40

The range in experimental values of k is great, but its effect on the maximal compressive stresses in the lowermost timber of the crib frame is not over 20 per cent, as shown.

Actual obervations have also shown that the value of k may increase with time, for a limited period, by as much as 100 per cent. This time effect may be accelerated by tamping the fill.

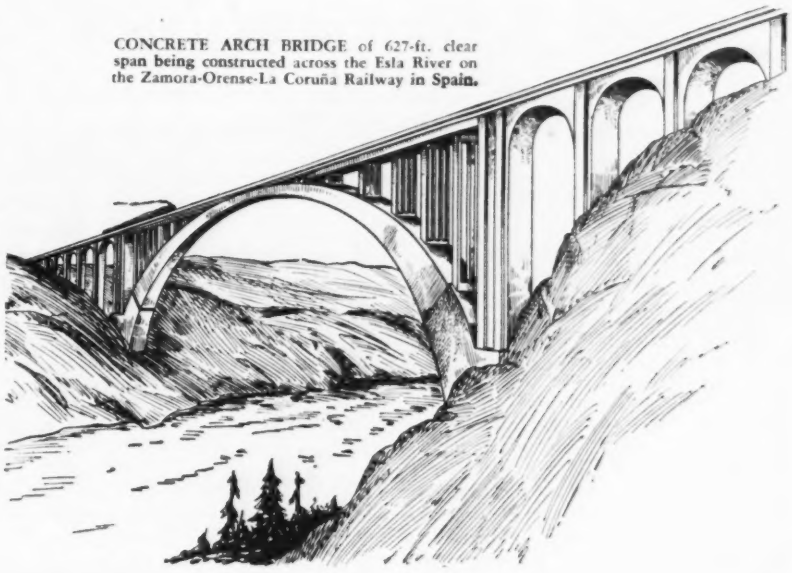
World's longest-span concrete-arch bridge

The double-track railroad line between Zamora, Orense and La Coruña, in Spain, will be carried across the Esla River on a concrete arch bridge, 1,545 ft. long, which has been in course of construction since August, 1934. This bridge, described by A. O. de Retana in *Cemento* of February, 1935, is to have a central arch of 627 ft. clear span, which makes it the longest reinforced-concrete arch in the world. The main arches of the Traneberg bridge in Sweden and of the Plougastel bridge in France, which have held the length record so far, have clear spans of 586 ft. and 566 ft., respectively.

The curve of the arch is a parabola of the fourth degree with a rise of 205 ft. As seen from the architectural drawing, the arch carries ten sets of spandrel columns, up to 127 ft. in height, supporting the two-track roadway. The arch is a hollow structure divided into three longitudinal compartments, throughout its length, varying in height from 12.1 ft., at the crown, to 19.7 ft. at the springing line. The total width of the arch box varies similarly from 25.9 at the crown to 29.7 ft. near the abutment. The longitudinal partitions have a uniform thickness of 2.3 ft., while the back and the soffit slabs vary in thickness from 2.95 ft. at the crown to 4.35 ft. at the abutments.

The arch is designed to satisfy the following conditions: (1) skewbacks submerged, or above water; (2) temperature variation of ± 18 deg. F.; (3) wind pressure up to about 28 lb. per sq.ft. The maximum stresses will be 1,182 lb. per sq.in. at the crown and 1,223 lb. per sq.in. at the abutments. These stresses are only about 28 per cent of the 90-day strength of the concrete, which will be proportioned with 590 lb. of portland cement per cubic yard. The job will require a total of 39,200 cu.yd. of concrete, and 1,100 tons of steel, and 763 M ft.b.m. of lumber for the arch centering.

The arch centering will consist principally of ten arched-truss ribs forming a system of uniform cross-section 31.2 ft. wide and 11.5 ft. high. The removal of the centering and the adjustment of the neutral axis of the arch will be carried out in accordance with the Freyssinet system, which proved highly successful in the construction of the Plougastel bridge. Thirty-six hydraulic jacks will produce a positive bending movement of 20,300,000 ft.-lb. at the crown, and 1,530,000 ft.lb. at the abutments. The keystone gap will be 6.3 in. wide at the extrados and 5.4 in. at the intrados.



CONCRETE ARCH BRIDGE of 627-ft. clear span being constructed across the Esla River on the Zamora-Orense-La Coruña Railway in Spain.

Level of Great Salt Lake Reaches All-Time Low

IN GREAT SALT LAKE the lowest water level for the year occurs in midwinter. Last winter the level went down to El. 4194.7, or 2.1 ft. below the zero line of the gage at Saltair, Utah, operated by the U.S.G.S. This is 1 ft. lower than the lowest water previously recorded (Nov. 15, 1905) and is the lowest level since recorded observations began in 1850.

At this low level the density of the lake water was found to have increased to a specific gravity of 1.23. On piles of the Southern Pacific trestle crossing the lake solids collected, as shown in the accompanying photograph. Section crews, using compressed-air drills, removed some of these deposits and reported the average quantity per brace pile to be 97 cu.ft., or 6,800 lb. per pile.

RAILROAD TRESTLE across Great Salt Lake accumulated heavy salt deposits as the result of low water level and increased density.

Book Reviews and Notes

A Monthly Commentary on Current Additions to the Civil Engineer's Library

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Public Works for Recovery

ENQUIRY ON NATIONAL PUBLIC WORKS—League of Nations—Organization for Communications and Transit—Paper; 8x11 in.; pp. 273; tables. For sale by World Peace Foundation, 40 Mt. Vernon St., Boston, Mass. $3.

TWENTY-NINE GOVERNMENTS have replied to an inquiry from the League of Nations as to their public-works undertakings since 1929. The subjects covered in the inquiry are: (1) a description of the main public works; (2) the principal administrative methods followed in the execution of the work; (3) the principal methods of financing the work; (4) allocation of the expenditures between labor and material; and (5) effect of the work upon the resumption of economic activity and upon unemployment. The answers are published, substantially in full, in the book noted above. Not all the questions are answered, especially the last two, but such expressions of opinion as are given as to the amount of money spent for direct labor and as to the effect of public works upon economic conditions will be fund of interest. While all recognize the value of public works in relieving unemployment, few express assurance that such expenditures have a definite effect in improving economic conditions.

Civic Design

OUTLINE OF TOWN AND CITY PLANNING—By Thomas Adams. Cloth, 6x9 in.; pp. 368; foreword by Franklin D. Roosevelt. Photographs. Published by Russell Sage Foundation, New York, N. Y. $3.

A CITY PLAN, says Thomas Adams in his introduction to this book, is only a means to an end, and that end is a stable and well-balanced physical structure so designed as to secure health, safety, amenity, order and convenience, and generally to promote human welfare. For this reason Mr. Adams prefers to call the whole art of city planning "civic design," to indicate that it involves much more than the drawing of plans. A city, he states, is an evolving and dynamic institution and hence has characteristics of growth that can only be partly controlled by human design.

The book is divided into two major parts, the first being descriptive of early efforts in city planning, and the second being a review of modern phases of urban growth and city planning. The former includes comment on the plan of many ancient and present-day cities. An appendix reviews the major aspects of city planning, namely, engineering, landscape architecture, architecture, sociology, economics and finance, and law. The latter section, confined to four pages, is a concise summary of the many elements that a civic designer must consider in the preparation and execution of his plan.

The book is well written and profusely illustrated. It contains a wealth of information on town and city development.

A Transport Summary

ROAD AND RAIL IN FORTY COUNTRIES—By Paul and A. Albitreccia. Cloth; 5x8 in.; pp. 455; tables. Published by Oxford University Press, London. $6.

IN 1931 the International Chamber of Commerce undertook "to determine the effect of the development of motor traffic upon railroad traffic in its various classes, and particularly those classes of goods traffic that are most affected," also "to consider the nature of the resulting modifications which may be desirable in the fundamental principles governing the railroad rate schedules." As the basis for such a determination, the chamber inaugurated a study of the fundamental conditions affecting rail and motor traffic in the principal countries throughout the world.

Forty countries were selected for study, in order to determine as accurately as possible what characteristics of the problem of coordinating rail and road transport are common to all countries, also to set forth in general terms what means had been found effective in bringing the transport agencies into proper economic balance. With this information available, it was believed that a student of the problem in any one country would be better able to judge as to what if any of the coordination plans of other countries will be applicable to their country.

This book is a summary of the finding. It is divided into two principal parts, the first being a summary of the road and rail transport situation in the countries surveyed, and the second is an analysis of the principal aspects of the road and rail problem. This latter includes legal aspects, taxation paid by railways and motor transport, measures taken by railways to meet motor-transport competition and social and labor legislation. As the authors point out, much-needed information is unavailable or fragmentary, and so the compilation falls short of what could be hoped for; but despite its recognized limitations the book will be found of value to all who would view the transport problem broadly.

Miscellaneous Notes on Booklets and Reprints

GRAVITY RETAINING WALLS and concrete walls are the subject of a report of the Institution of Structural Engineers, 10 Upper Belgrave St., London, S.W.1, England. Price, 1s. 6d.

THE HYDRAULICS OF DROP INLETS AND SPILLWAYS for erosion-control structures, experimental investigations—Engineering Experiment Station, Series No. 80, University of Wisconsin, Madison, Wis. Price, 25 cents.

OBSERVED SOIL PRESSURES on the deep sewers of the North Toronto system—Bulletin 145, Faculty of Applied Science and Engineering, School of Engineering Research, University of Toronto, Toronto, Ont., Canada.

DESTRUCTIVE AND NEAR-DESTRUCTIVE EARTHQUAKES in California and western Nevada, 1769-1933—Special Publication No. 191, Coast and Geodetic Survey. For sale by the Superintendent of Documents, Washington, D. C. Price, 5 cents.

SPILLWAY HYDRAULICS FOR SMALL DAMS, a section of the 16th biennial report of Robert E. Kennedy, state engineer, North Dakota, has been published as a separate reprint and may be obtained from the state engineer's department, Bismarck, N. D.

AN INVESTIGATION OF THE PERFORMANCE of large centrifugal pumps using air as a medium—Engineering and Science Series No. 48, Rensselaer Polytechnic Institute, Troy, N. Y. This thesis has been published by Rensselaer Polytechnic Institute as indicating a method whereby the performance of large centrifugal pumps can be obtained directly at the manufacturer's laboratory.

STUDIES OF THE FLOW OF WATER UNDER DAMS and on related subjects before the Punjab Irrigation Research Institute have been printed as separate papers. They are as follows, the price of each in British currency being given in parenthesis: "A Study of the Flow of Water Under Works on Sand Foundations by Means of Models," Part I and Part II (5d. each); "An Investigation of the Flow of Water Under Khanki Weir and the Pressures on the Floor" (1s. 6d.); "An Investigation of the Pressure on Works on Sand Foundations," Part I (1s. 6d.); "Studies on Subsoil Hydraulics, Investigation of Observational Methods for Models" (1s.

9d.). Two papers on silt, "The Transmission Coefficient of Water in Natural Silts" (7d.); and "An Optical Lever Siltometer" (1s. 6d.). These may be obtained from the Superintendent, Government Printing, Punjab, Lahore, India.

THE MERSEY TUNNEL is the subject of an illustrated brochure published by the Stanton Iron Works Co., Ltd., Nottingham, England, the manufacturer of the iron paving used in the tunnel and of the cast-iron segments forming the tube.

FLOODS AND ACCELERATED EROSION in northern Utah is the subject of Miscellaneous Publication No. 196 of the U. S. Department of Agriculture. Overgrazing and fire have resulted in an alarming acceleration of erosion in the Wasatch Mountains near Salt Lake City. This study has served as a basis for a program of erosion and flood control.

HIGHWAY GRADES AND MOTOR VEHICLE COSTS—Bulletin No. 7, Engineering Experiment Station, North Carolina State College of Agriculture and Engineering, State College Station, Raleigh, N. C. Price, 20 cents. This pamphlet sets forth a method of determining the effect of grades on the cost of highway transportation based on the assumption of a constant speed. It also takes into account the peculiar characteristics of internal-combustion motors.

CITY PLANNING AT YONKERS, N. Y., is outlined in the 1934 progress report of the city planning commission. In its 205 pages the book discusses at length the city's history, geography, population, commerce and industry, transportation, transit, traffic, streets, parks, public education, land subdivision, zoning, private buildings, housing, public buildings, refuse disposal, and municipal finance and administration.

INTENDED TO BENEFIT USERS OF WHITE FIR, loggers, manufacturers and distributors, U. S. Department of Agriculture Bulletin 408, "Properties of White Fir and Their Relation to the Manufacture and Uses of the Wood," is a joint production of R. P. A. Johnson, engineer, Forest Products Laboratory, and M. R. Brundage, associate forester, California Forest Experiment Station, both of the U. S. Forest Service. White fir, according to the bulletin although admittedly less valuable than some of the species with which it is associated in the forests of the West, is the subject of a great deal of unjustified prejudice that originated in faulty preparation of the lumber for market, careless marketing practice and lack of understanding and improper usage by the ultimate consumer. Against this prejudice the bulletin sets forth the results of thousands of actual strength tests as well as facts obtained in extensive surveys of white fir manufacture, marketing and use. The bulletin carries tabulations and discussions of every important property and use of white fir. Copies may be obtained from the Superintendent of Documents, Washington, D. C., 10c. each.

CARTOGRAPHIC STUDY OF DROUGHT—A reprint from the quarterly journal, Royal Meteorological Society, 49 Cromwell Road, South Kensington, London, England.

MINERAL RESOURCES and Possible Industrial Development in the Region Surrounding Boulder Dam, is the title of a pamphlet issued by the U. S. Bureau of Reclamation. It contains three reports. One is a field study of mineral resources of the region, another covers the economic factors to be considered in the development of mineral industries tributary to Boulder Dam, and the third covers the cost of electrical energy at the dam and delivered at points 100 and 200 miles distant.

AERATION OF SEWAGE by Sheffield paddles and by an aspirator was carried out experimentally at the Engineering Experiment Station, Urbana, Ill., by Prof. H. E. Babbitt. With an ordinary domestic sewage, practically free from industrial wastes, a satisfactory activated sludge was formed and an effluent of desirable quality was obtained by both methods. Bulletin 268, of 54 pages, describes the experiments, which were carried out with paddles in 1929 and with the aspirator from 1930 to 1933.

A LOG BOOK OF LOW-COST HOUSING MOVEMENT for the past one and one-half years has been issued as the first annual Housing Officials Year Book, 1935, by the National Association of Housing Officials, Chicago. It reports the proceedings of all the agencies in the public housing field, and reviews the problems and policies of PWA, FHA, HOLC, subsistence homestead and rural rehabilitation agencies. Reports of certain state and local housing agencies are included. Published for NAHO by Public Administration Service, Chicago. Price, $1.

IN A BOOKLET entitled "Joints for Concrete Pavement," L. G. Mensch, 307 N. Michigan Ave., Chicago, Ill., develops his ideas of proper joint detail by an extensive analysis, first, of stresses in slabs and, second, of dowel action. The conclusions of these analyses and of a considerable number of tests result in the recommendation of two specific designs whose basic features include: dowels of large diameter, of hollow cross-section, and of high-yield-point steel, and a prefabricated frame of steel to which the dowels are permanently fastened in such a manner that they are in correct position and direction once the frame is lined up. Fillers of cork, wood or fiber capped with a zinc strip to exclude dirt and moisture are used in one design; the other involves an air cushion. Price, $1.

New Books and Revised Editions

[Those desiring copies of the books listed below or mentioned elsewhere in this section should order them from the publishers or from their local booksellers.]

ANALYSIS OF FRAMED STRUCTURES—By John H. Matthews and Phillip E. Soneson. Cloth; 6x9 in.; pp. 313. Published by McGraw-Hill Book Co., Inc., New York City. $3.50.

ANNALI IDROLOGICI-1933. Part II—Paper; 10x14 in.; pp. 202. Mostly charts, maps and tables. Published by Istituto Poligrafico Dello Stato, Rome, Italy.

BRICK ENGINEERING, VOL. III—Reinforced Brick Masonry—By Hugo Filippi. Paper or fabrikoid, 6x8 in.; pp. 240; photographs, diagrams and tables. Published by the Brick Manufacturers Association of America, Cleveland, Ohio. Price: paper, $2; fabrikoid, $2.50 . . . *Volume I of this series is out of print; Volume II—Design and Construction of Brick Buildings—is still available; paper, $0.50; fabrikoid, $1.*

DIE ARÄOMETE-METHODE ZUR BESTIMMUNG DER KORNVERTEILUNG VON BÖDEN—und anderen Materialien. By Arthur Casagrande. Paper; 7x10 in.; pp. 56; diagrams and tables. Published by Julius Springer, Berlin, Germany. Price 4.50 RM.

COMPILACION DE LOS ESTUDIOS GEOLOGICOS OFICIALES EN COLOMBIA-1917 a 1933 Tomo II—By Otto Stutzer and Ernst A. Scheibe. Paper; 7x10 in.; pp. 425. Photographs, maps. Published by Seccion de Publicaciones, Belisario Vejarano, Bogota, Colombia.

CONSTRUCTION COSTS—1910-1934; 1935 Edition—Paper; 9x12 in.; pp. 95. Line drawings and tables. Published by *Engineering News-Record*, 330 West 42nd St., New York City. $1.

FEDERAL RECLAMATION—By John W. Haw and F. E. Schmitt. Paper; 6x9 in.; pp. 133. Map, diagrams. Published by U. S. Dept. of the Interior, Washington, D. C.

THE FORMATION OF CAPITAL—By Harold G. Moulton. Cloth; 5x8 in.; pp. 203. Diagrams. Published by The Brookings Institution, Washington, D. C. $2.50.

HANDBUCH FÜR EISENBETONBAU-Stützmauern Grundbau—Fourth edition. By O. Mund and O. Colberg. Paper; 7x11 in.; pp. 97-192; diagrams, tables and halftones. Published by Wilhelm Ernst & Sohn, Berlin, Germany. Price 6.60 RM.

A METHOD FOR THE MECHANICAL TESTING OF CEMENTS—By Ary F. Torres and Romulo de L. Romano. Paper; 7x10 in.; pp. 53. Photographs, tables, diagrams. A translation into English, published by Institute for Technological Research, Sao Paulo, Brazil.

PRACTICAL DESIGNING IN REINFORCED CONCRETE—PART III—By M. T. Cantell. Cloth; 6x9 in.; pp. 225. Photographs, tables, diagrams. Published by E. & F. N. Spon, Ltd., London, England; and Engineers Book Shop, 227 Park Ave., New York, N. Y. $5.

DIE RISSFRAGE BEI HOHEN STAHLSPANNUNGEN UND DIE ZULÄSSIGE BLOSSLEGUNG DES STAHLES—By Fritz von Emperger. Paper; 6x9 in.; pp. 126; diagrams and halftones. Published by Österr. Ingenieur-und Architektenverein, Wien, Austria. Price 7M.

SEEHAFENBAU—Bana III. By F. W. Otto Schulze. Paper; 7x10 in.; pp. 80. Diagrams. Published by Wilhelm Ernst & Sohn, Wilhelmstrasse 90, Berlin W8, Germany. Price, 5.70 RM.

WATER-POWER: Its Estimation and Development with Reference to India—By J. W. Meares. Cloth; 5x8 in.; pp. 196. Diagrams, tables. Published by W. Thacker & Co., 8 Ludgate Sq., London, E.C.4, England.

TABLES DE CALCUL DIRECT DES SECTIONS EN BÉTON ARMÉ—By Gabriel Ledent. Paper; 6x9 in.; pp. 39; tables and diagrams. Published by the author, Av. Plasky, Bruxelles, Belgium. Price 20 fr.

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April 25, 1935

Sanitary Fill Possibilities

ALTHOUGH it is one of the least costly methods of disposing of municipal refuse, the sanitary fill has a poor reputation in this country because most communities that have employed it have succumbed to the temptations that it presents and, through lax operating methods, have permitted the fill to degenerate to a state that is anything but sanitary. The method of operation worked out at Fresno, which is described in detail on another page, is of special interest in this regard, for it is to a large degree self-governing in its inherent requirement that cuts and fills balance each other. In any event, however, the sanitary-fill method of disposal is wholly dependent for its success upon careful and conscientious operation. Relaxation in this regard means disaster inevitably. But with constant care the sanitary fill can provide completely satisfactory disposal at unusually low cost. Its use in ways similar to those put into practice at Fresno deserves the careful consideration of municipal engineers.

Speed Crossing Elimination

ORGANIZED CONTRACTORS in New York State have protested to the governor over pending legislation that would take grade-crossing improvement under the Federal Emergency Relief Act out of the hands of the state highway department, designated by the act for this work, and put it in the hands of the public service commission. Heretofore crossing elimination in New York State has been carried out by the railroads (who bore half the cost) under the direction of the commission, but progress has usually been slow because of the required formal orders, hearings, etc. The contractors are right. The "normal procedure" would paralyze the purpose of the new public-works act, for the work could not start promptly. Speed in undertaking and prosecuting the work is attainable only when the work is done under a department unhampered by the requirements of existing statutes. The case further emphasizes the need for well-considered procedure in carrying out grade-crossing elimination work under the relief act if there are to be no unnecessary delays. For example, though the states are required to provide right-of-way only, they and the railroads being relieved of all other costs, yet difficulties and delays are likely to arise from such questions as to how track changes and temporary track supports are to be handled and who is to pay for them initially. Matters of this character need early consideration if they are not to become sources of delay.

Arch and Truss

ANOTHER BOLD ACHIEVEMENT of the structurally ingenious European mind comes to notice in the Castelmoron Bridge. The lightness of this structure is attributed partly to its unsymmetrical hinge arrangement and inclined hangers and partly to the careful application of precast arch rib sections in combination with high-strength concrete and well-placed reinforcement. The value of the latter factors will be recognized without question, while the influence of the former will be subject to differences of view as between European and American engineers. On this side of the water the merits of hinged construction are certain to be weighed against the increased stability and security of a structure continuous from foundation to foundation. The exceedingly interesting approach to truss construction represented by the triangular web system tends to raise some question as to whether the designers abandoned full reliance on the inherent qualities of the arch or whether they merely transferred the normal bending moments of the unrestrained arch rib to secondary stress action. In all the distinguishing items of this structure, however, American practice is notoriously more conservative than that of Europe, and primarily for this reason the design invites study.

Corporate Engineering Practice

NEW YORK STATE has just taken steps to check the practice of engineering by corporations. The education law has been amended to require that no existing corporation nor any new one may practice engineering unless its chief executive officer, or each member of the firm (if a co-partnership), holds a license to practice engineering. No new business corporation may use the term "engineer" or "engineering" in its title, and no old one may change its name or sell its title without the consent of the department of education. In taking this step the state is following the lead of the other professions. Practice of medicine or law by corporations has long been forbidden, but when the engineers first tried to write such restrictions into license laws they were opposed by politically powerful corporations that were practicing engineering. However, experience in administering the law in New York State brought convincing support to the legislation introduced this year. The licensing board had clear evidence of practice by corporations made up of men who were unable to obtain a license but who could employ an engineer to go through the formality of signing their plans. Such practice is now eliminated. No firm can advertise to the public that it is qualified to practice engineering unless its responsible officers are qualified men. This is a step that should be followed by all states that still permit practice by corporations. It is a return to personal responsibility in engineering.

Problems in Groin Action

SOME EXPERIENCES with spurdikes and groins show variations in action under different conditions that suggest the need for better knowledge of the controlling factors. Permeable spurdikes have made a distinct success in river stabilization service, notably along the Missouri River, and it appears from more limited data that permeable construction has also made a good showing on the shores of the Great Lakes. On the other hand, solid spurdikes have repeatedly been failures in similar service. Seacoast erosive actions appear to be of another kind, for it has been found that groins to protect ocean beaches from erosion must be tight, a conclusion most strongly established in New Jersey practice, where there is a long history of systematic groin

construction. It is an interesting question whether the mechanics of wave and current action differ for the two groups of cases, or whether the characteristics of the solid material, or perhaps other factors, are responsible for the reported difference. The only effective attack on the problem is that of laboratory study. This is quite in accord with the views expressed by Capt. R. S. Patton, of the Coast and Geodetic Survey, who suggested in an address to the American Shore and Beach Preservation Association two weeks ago that the subject of shore protection should be put into the laboratory. With well-equipped institutions for laboratory study available at Vicksburg and at the Bureau of Standards in Washington, it should be possible to find means for initiating such research.

Aligning a New Course

OUR COURSE in roadbuilding in the United States has until recently been fairly clear. It was to open up through routes for traffic. The choice of the most important routes was fairly obvious, and the wisdom of assembling these routes into systems of connecting lines became apparent almost at once. Through consistent effort along this course the federal-aid and state highway systems have developed as we now know them.

The problem of former days has undergone progressive change, however, and today the task to be performed is of quite different nature. It is now essential that a new course of highway thinking and road development be marked out.

We have long been definitely out of the Good Roads Era—the time when mere mass enthusiasm for "getting out of the mud" sufficed to define the objective. For some years after the end of that era we continued to be occupied with the first major assignment of opening up and improving the important obvious traffic routes. Now we are at the point where highway improvement becomes a matter of meeting precisely calculated needs.

That our present road system is fragmentary and inefficient, despite the large investment that has been made and the brilliant effort that roadbuilders have given to its creation, is known to every careful observer. The coming task is to develop the present fragment of a road network into a truly efficient system of transportation facilities. For this purpose thorough and calculated planning is indispensable. And before that planning can be undertaken, surveys and research must provide the quantitative data without which it is not possible.

What renders this work more difficult is the problem of what today we call, for convenience, secondary roads. Roads that are secondary from the old point of view but are destined to become integral parts of the primary system cannot be selected, or planned, or designed, by the primitive methods that were adequate heretofore.

But the need of careful planning is even greater in developing metropolitan sections of trunk-line roads, and in the refinement for speed and safety of main roads generally. And quite new questions are presented in the creation of that express-road or superhighway system that traffic is certain to demand to link up the greater centers of population and industry, a road type discussed in this column two weeks ago. These roads are costly structures, and mistakes are correspondingly expensive; for this reason intelligent planning is essential as a safeguard against the losses that result from error.

Such planning has to be begun at once. The problems involved are not to be solved out of hand; comprehensive surveys of social effects, of resources and of traffic are necessary before a sound solution can be approached. And rapidly increasing traffic requirements will soon be so crowding for that solution that it should not be delayed.

In all justice it must be recognized that little has been done so far to provide data for precise calculation of service value and economics of roads. What, for example, is the transportation value created by the past two years of emergency highway work? Until that question is answered, until we are able to show by convincing balance sheet that the work performed under the emergency acts had other justification than as a relief measure, we cannot pretend to be equipped properly for planning and designing the road construction of coming years.

More broadly, the roadbuilding art faces the challenging question as to whether the system that has been built to date is adequate for the service demanded by present-day transportation needs. Do the fair demands of increased transportation efficiency and the still greater demands of social betterment call for further improvement, and if so what kind of improvement and where should it be located? Questions of this kind, questions that when answered will tell us whether highway investment is as profitable as it might and should be, must become the objective of thorough and systematic study, for until the facts that answer them are definitely determined the proper advancement of the road system will be in constant danger of a check.

The direction of the new course of highway planning is clear. Each state, through its highway department or other appointed agency, must undertake a survey directed to the discovery of its future road needs in line with developing social and economic trends. A few states have already organized such highway studies. No state should longer delay action; if authority does not now reside in existing executive agencies, it should be sought by legislative enactment. To help financially, the present great federal-road grants provide that up to 1½ per cent of each state's allotment may be spent for planning purposes.

Supporting the states there is needed direct action by the federal highway authority to interest and coordinate nationally all bodies of highway users in the support of a planned program that will bring about the following objectives:

First, plans for an integrated highway system that will include all roads to be improved in the next twenty years, with clear indication of priorities.

Second, a budget of highway earnings and expenditures for a similar future period.

Third, a factual survey of present road service and of the amount, kind and cost of further improvement required to reach fully satisfactory service in the light of expected traffic.

This is an ambitious program, truly. But it is a less forbidding prospect than the present accomplishment of federal-aid and state highway systems would have seemed a score of years ago. It can be carried through if the will to do it is created. It is a challenge to vision, to higher degrees of proficiency and to unexplored possibilities of service by highway engineering. It is the obligation and opportunity of the art to meet this challenge and to place road development in an unassailable position.

CURRENT NEWS

Construction Work By Manufacturers Subject of Agreement

THE MANNER in which construction work by the maintenance forces of cotton textile manufacturers will be carried on is the subject of an agreement reached between representatives of the Construction Code Authority and the Cotton Textile Industry Committee. The agreement has been submitted to the NRA for approval. Necessity for such an agreement was brought about by a compliance case against a cotton textile manufacturer who used maintenance employees to construct a small addition to his plant facilities. The definition of the construction code being very broad in coverage, the question arose as to whether certain operations of manufacturers are to be governed by the provisions of the cotton textile code or by the construction code.

The agreement ratified by the two code authorities states that upon approval of the agreement by NRA all questions of overlap shall be resolved along the following general principles:

1—Operations performed by a manufacturer who is subject to the cotton textile code on his own premises and not for compensation or hire shall be governed by the cotton textile code when confined to repair and maintenance items, and to minor items of repair, alterations and additions in so far as such work is done by the manufacturer's employees holding regular jobs providing permanent employment; however, employees temporarily engaged for such work shall be governed by the construction code.

2—All other construction work performed by a cotton textile manufacturer shall be governed by the construction code.

3—A joint committee of equal representation shall pass on cases in dispute, and in the event of disagreement, they shall call in an additional impartial member whose views shall be accepted as those of the committee. The report of such committee shall be accepted and supported by the respective code authorities.

There is no indication as to what action NRA will take with respect to the proposed agreement, which has been circulated to the various advisory boards. While the action of the two code authorities in attempting to solve a vexatious problem is commended, some question is raised as to the power of code authorities to effectuate such an agreement, and whether it would be binding upon members of the industry without public hearing or an opportunity to present comments. Another complication is presented by reason of the fact that it will affect the various divisional chapters of the construction code which are not directly represented in the action of the Construction Code Authority.

Some special provisions

Several of the divisional chapters contain provisions bearing specifically on the problem. The painting chapter exempts such services when performed by permanent employees of any building owner or tenant on buildings or structures owned or occupied by such owner or tenant, and not for hire. The term "permanent employee" is defined as an employee who is given regular and continuous employment for a period of not less than six months. The electrical contracting chapter exempts the maintenance of existing electric wiring, devices or equipment, or the moving or relocating of equipment within a plant performed by the owner's or tenant's permanent employees for electrical maintenance work, with "permanent employee" defined substantially in the same manner. The heating, piping and air conditioning contractors' chapter makes a similar exemption.

The exemption as provided in the joint agreement places the emphasis upon the job rather than upon the employee, having in mind maintenance crews regularly employed by manufacturers, and usually consisting of employees skilled in several crafts. In the opinion of many persons in the construction industry, the line of demarcation can be logically drawn by exempting from the provisions of the construction code construction work performed by employees holding regular jobs embracing such work or operations and providing permanent employment when confined to repair and maintenance items and to minor items of replacement.

Funds for Geological Survey And for Park Work Increased

The appropriations bill for the Department of Interior, passed by both houses of Congress, carries increases for the Geological Survey and the National Park Service for the year ending June 30, 1936.

Of the $350,000 added to the Geological Survey budget, $150,000 will be used to increase the amount available for stream gaging and reports on water resources to $767,000. For geological surveys the amount was increased from $335,000 to $450,000, while smaller amounts went to investigation of Alaska's mineral resources, and to mineral leasing.

The National Park Service received $7,500,000 for construction and maintenance of roads and trails.

Water Rights of Direct Users Held Supreme in Colorado

The rights of farmers to water for direct irrigation have been held paramount to storage rights in a decision by the Colorado supreme court.

The ruling was handed down in a suit brought by the Park Reservoir Co., which had been denied the right to store the waters of Surface Creek in Delta County by the action of the state engineer, M. C. Hinderlider. The storage right was withheld when it was determined that even at its highest flow the stream could not satisfy all priorities.

Justice Burke of the supreme court held that the reservoir company was not being deprived of its property without due process on the ground that the company never had a right to the water as against users for direct irrigation. The court contended that the law authorized storage only when the water was not needed for direct irrigation.

Engineering Practice By Corporations Limited in New York

PRACTICE of engineering by corporations in the state of New York has been closely limited by an amendment to the education law recently passed by the legislature and approved by the Governor.

As amended, Section 1,461 of the law now reads:

No corporation shall be granted a license under this article, and no corporation shall practice or offer to practice professional engineering or land surveying in this state except as hereinafter in this section provided, nor shall any corporation hereafter formed use or assume a name involving the word "engineers" or "engineering" or any modification or derivative of such terms, except a non-profit membership corporation composed exclusively of professional engineers. Nothing herein shall apply to a corporation, partnership or joint-stock association, organized and existing under the laws of the state of New York, which on the 15th day of April, 1935, and continuously thereafter, was lawfully practising professional engineering or land surveying in New York state, and then only provided that the chief executive officer, if a corporation, and each member, if a firm, co-partnership or joint-stock association, shall be a licensed professional engineer, if practising professional engineering, or a licensed land surveyor if practising land surveying, and provided, further, that the person or persons carrying on actual practice of engineering or surveying on behalf of, or designated as "engineer," or "surveyor," with or without qualifying or characterizing words, by such corporation, partnership or joint-stock association, shall be authorized to practice professional engineering or land surveying as provided in this article. No such corporation shall change its name or sell its franchise or transfer its corporate rights, directly or indirectly, to any person, firm or corporation, without consent of the [Education] department.

Law evasion

Heretofore the same section read as follows: "Nothing herein shall apply to a corporation, partnership or joint stock association, provided the person or persons carrying on the actual practice of engineering on behalf of such corporation, partnership or joint stock association shall be licensed engineers." This provision was so broad that it was found, in attempting to enforce the law, that it provided a loophole through which the law could be evaded by men who were unable to obtain a license but wished to carry on work of an engineering nature. Such men, by incorporating and hiring a licensed engineer to go through the form of signing their plans, were able to evade the law.

In form, the revised section of the engineer license law follows closely that of a similar section of the education law applying to the practice of architecture, and both are an approach to accepted practice in the legal and medical professions where practice by corporations is entirely prohibited.

When the engineer license law was first proposed there was much controversy over the subject of restricting the practice of corporations, and it was not found possible at that time to write in a provision as restrictive as the one now approved.

Smaller Projects Get Consideration By President's Relief Work Plan

(Washington Correspondence)

PRESIDENT ROOSEVELT'S "clearing house" plan of developing the work relief program will give consideration to every possible method of spending the $4,000,000,000 appropriation. A multitude of small projects—$250,000 is regarded as a good average, coupled with definite time schedules for completion, is relied upon to form the backbone of a fast-moving work program distributed over a large territory. Selection and location of projects according to the number of idle workers on relief rolls in a given area will bring the job to the man. New York and other large cities will form single districts, while in regions of sparse population, the administrative districts will be as large as practical operating factors will allow.

Big projects which have featured the PWA program, such as Boulder dam on the Colorado River, Grand Coulee on the Columbia and the Triborough bridge in New York obligate huge funds but expenditure is slow. By calling upon a "round table conference" that includes not only federal agencies but "outsiders" as well, to bring forward projects, the President expects to develop variety, both in type and size in which for example, reclamation projects that necessarily require some time to bring to completion are balanced by smaller municipal improvements in areas where there is a heavy concentration of idle labor on relief rolls.

New division set up

The clearing house is to be known as the Division of Applications and Information and is to be headed by Frank C. Walker, former director of the National Emergency Council. All proposals will clear through this division before going to the allotment board headed by the President.

The bulk of the work under the $4,000,000,000 appropriation will be handled by existing government departments and agencies, but three new agencies will be created for the life of the program to handle grade crossing elimination, rural electrification and rural resettlement. The first will be a division of the U. S. Bureau of Public Roads, and the other two will be independent. Tugwell will have charge of resettlement but will continue as Undersecretary.

It is President Roosevelt's intention to draw 3,500,000 workers exclusively from relief but as practically every phase of the program involves construction in some form, the production of materials and equipment will reduce unemployment among other millions who are not on relief but are waiting the revival of the heavy industries.

To get consideration, all project proposals must show how many men will be used off relief rolls and set a definite date by which the job can be completed.

Necessity for speed emphasized

The emphasis on speed is explained by the President's declared purpose to spend the $4,000,000,000 appropriation by July 1, 1936. But before dirt can fly, allotments must be made, and projects must be approved. Various types of projects require more time for preparation, of course, but there was no satisfactory explanation of the President's statement that two months will be needed to get ready. The $800,000,000 road and grade-crossing elimination program is waiting. P. W. Administrator Ickes has $100,000,000 in municipal projects all ready to release as soon as the money can be turned over. The Bureau of Reclamation needs a long start as two months' delay often means that a year is lost in regions where the season is short.

President to direct program

In assuming personal direction of the program, the President has accepted the responsibility for the result. Allotments previously made by Administrator Ickes, as chairman of an interdepartmental board, now will be made by Mr. Roosevelt, after listening to the suggestions of his "round table." The mechanics of engineering and construction remain much the same as in the past. Federal projects either will be undertaken by existing government agencies which receive the allotment or will be supervised by them. Non-federal projects will be handled by PWA. Time-scheduling is counted upon to provide a momentum that the old public works program never gained but the President's emphasis on the old "money back" policy is a disturbing factor. The rate of interest will be cut below the 4 per cent charged states and municipalities by PWA but, as far as possible, such non-federal projects will be financed by loans only in the future. The amount of every grant will be a "trading proposition." Such negotiations for obtaining federal largesse will require some time, are likely to become acrimonious, and discrimination will be charged if one city obtains 30 per cent, and another only 20 per cent.

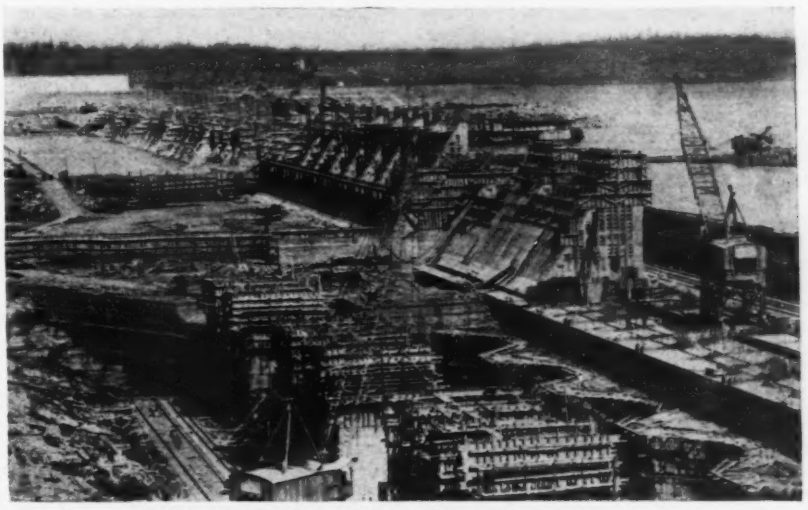
Court Upholds Bid Depositing Under the Construction Code

Violation of the provision of the construction code requiring the filing of duplicate bids with a bid depository established by the Construction Code Authority was enjoined on March 29 by the United States District Court in Massachusetts which issued a decree against a Boston contracting firm. The decision is looked upon as significant in upholding the operation of bid depositories, an important feature of the construction code, and guarding against bid peddling and bid shopping.

New England Road Builders Discuss Highway Requirements

Highway construction as a quick means of employment relief and as a continuing necessity was the keynote of the annual meeting of the New England Road Builders Association at Boston, Mass., on April 16. Re-elected president, Louis R. Perini declared that for many years to come the need of improved highway facilities will be emphasized by the demands of constantly increasing motor vehicle traffic. He pointed out that a large part of the existing highway system of the nation is unsuited to present traffic requirements and stated that the ultimate restoration of general business will automatically restore to the highway industry an opportunity to operate "on its own," and not primarily as a relief agency.

Joseph A. Tomasello, treasurer of the Association, referred to the analysis of a test project in Massachusetts for which complete and accurate costs were kept as requested by the Bureau of Public Roads. This study shows that the total cost of the direct-labor work was 45 per cent greater than the cost would have been if done by the contractor at the price submitted. The total cost was $104,015, compared with a contract bid of $71,708 for 8,550 ft. reconstructed with a bituminous concrete surface.



JOE WHEELER DAM RISES ABOVE THE TENNESSEE RIVER

Concrete in the cofferdams at the east side of the channel at Joe Wheeler Dam on the Tennessee River is rapidly rising above river level. This picture, taken early in March, shows the power-house section in the foreground. The deep cuts at the right center are for the draft tubes, and the tailrace excavation is at the left. In midstream openings are to be left through the body of the dam above the foundations to pass the river flow while the east half of the river is being unwatered. On the far shore is the wall of the navigation lock. The dam is being built by the TVA.

Contractors Oppose Crossings Control By N. Y. Commission

BOTH HOUSES of the New York legislature have passed and transmitted to Governor Lehman a measure designed to place control and expenditure of New York State's share of federal funds for railroad grade crossing elimination work under the railroads and the public service commission. Under provisions of the federal act, New York's share of the grade crossing fund, amounting to slightly over $20,000,000, would be expended under the complete supervision of the division of highways of the department of public works, a uniform policy of handling such work having been laid down in the law for all states.

Commission now controls

The New York public service commission and the railroads have long had supervision of grade crossing work financed 49 per cent by the State (bond money), 50 per cent by the carriers and one per cent by the county in which the work is located. Similar supervision would be continued under the terms of this bill although the new work would be completely financed by the federal government.

Organized contractors of the state, through the Associated General Contractors of America, New York State Highway Chapter, have urgently requested Governor Lehman to veto the bill, pointing out that if the state is to realize the full benefits of the $20,000,000 grade crossing fund at the earliest possible date, it is necessary that these projects be handled by the department of public works. The record of that department in the speedy handling of federal highway funds in the past is pointed to as evidence that the grade crossing work can be quickly launched thus stimulating industry and employment. In contrast to this, construction followers have noted the complications and delays incident to conduct of grade crossing work in past years where the work was carried on under supervision of the public service commission and the railroads.

Bidding limited

The organized contractors of the state have also viewed this subject from another angle. Where supervision and control of the expenditure involved rests with the commission and the various carriers, only a selected list of contractors will be permitted to bid on the work, the practice in the past having been that the individual carrier interested in a project could invite bids from a small group of its own choosing, and make awards accordingly, provided approval was secured from the commission. If the proposed program is carried on through the department of public works, as proposed by the federal act, all contractors possessing the necessary qualifications for this type of work will be given an opportunity to submit proposals.

As an evidence of the delay experienced in connection with railroad crossing elimination work as carried on at present, Frederick Stuart Greene, superintendent of public works, in a report to the legislature early this year, cited more than 100 projects, estimated to cost in excess of $31,000,000 which have been subjected to "extended delay." A number of them were originally ordered undertaken in 1927 and all of the balance were ordered at various dates prior to October, 1932, but none of them were advanced to the award stage. Of the projects more recently ordered, considerable delay has also been noted. During the year 1934 the Public Service Commission ordered action on projects involving estimated cost of $19,500,000. Projects involving but slightly over $3,000,000 were placed under contract during that year.

Illinois Water Works Men Discuss Purification Problems

More than 135 waterworks superintendents, operators and representatives of associated interests attended the meeting April 10 and 11 of the Illinois section of the American Water Works Association at Springfield. A dozen technical papers relating to problems of source, distribution, operation, purification and administration of water supply systems were presented. L. I. Birdsall in the report of the section chairman said that the chances of passing a bill to license operators are not at all promising. Constitutional questions are in the way.

The officers elected for the ensuing year are: chairman, Wesley W. Polk, vice-chairman, Charles H. Spaulding, treasurer, F. G. Gordon, and secretary, W. D. Gerber, Urbana.

A state-wide inventory for possible inclusion in the new appropriation lists 6,100 projects, aggregating $1,154,000,000, but many of these are for relief and will not be considered under the $900,000,000 public works allocation.

Code Committees Authorized For Architects and Engineers

Pending approval of the divisional chapters of the construction code for architects and engineers, and the establishment of divisional code authorities thereunder, the Construction Code Authority has authorized the appointment of administrative committees for these two branches of the industry. So far, only the chairmen have been appointed. William Stanley Parker of Boston, a member of Sturgis Associates, is chairman of the architects' committee, and Carlton S. Proctor, of Moran and Proctor, New York, is chairman of the professional engineers' committee. The appointees are chairmen of the unofficial code committees that have been sponsoring the proposed divisional chapters.

Under the provisions of the code, the Construction Code Authority is authorized to administer the code in any branch of the industry for which no divisional code authority shall have been established. Until their divisional chapters are approved, the architects and professional engineers are subject only to the provisions of Chapter I of the construction code, the general provisions. The administrative committees will serve as advisers in the interests of their particular groups, or perform such administrative duties as may be delegated by the code authority.

New York Engineers Endorse Administration of Work Relief

The manner in which the works division of the Emergency Relief Bureau of the City of New York is being administered—the subject of several acrimonious hearings before an aldermanic investigating committee—was strongly endorsed by the Metropolitan Section of the American Society of Civil Engineers at its regular meeting held in New York on April 17. The works division is headed by William J. Wilgus, director, and J. P. H. Perry, deputy director, both members of the Am.Soc.C.E. Colonel Wilgus has been the target of attack before the aldermanic committee. The section put itself on record with city, state and federal relief agencies as having entire confidence in the manner in which the work of the division is being carried on.

The section also put on record with the aldermanic committee and the relief agencies a statement as to the character and constitution of the Professional Engineers Committee on Unemployment in view of the fact that statements derogatory to the activities of that committee had been made at the aldermanic hearings. The section pointed out that the P.E.C.U. was a non-profit organization for the relief of engineers, that it had been in operation since 1931, that it is supported entirely by voluntary contributions by engineers, and that it has cooperated with the several city relief agencies during the past three years in providing skilled men to direct relief operations.

Labor Costs Retard Building, Is Opinion of N.E.C. Head

That building recovery is being held up only by labor costs, is the opinion W. L. Carter, president of the New England Council, expressed in an address to the Council recently. Rents have increased slightly, but are still 30 per cent below the 1929 level while building costs, which are chiefly labor costs, are almost at the 1929 level. Until construction costs and rents are more nearly equalized so that owners see a chance for profit they will postpone rebuilding.

Cheap money for building is not the answer, Mr. Carter states. Low interest rates and long term repayments will not reduce the cost of building. Labor costs, it is pointed out, must be revised, not to the old levels of sweat shops, but moderately to a point where volume of building is increased.

Ontario Power Contract May Not Be Cancelled

Cancellation of the contract made by the Hydro-Electric Power Commission of Ontario for the purchase of power from private companies in the province of Quebec, as called in legislation passed by the provincial legislature after one of the most heated controversies in its history, may not become law because the act did not receive royal assent before the legislature was prorogued on April 18. Now the act will not become effective until it shall be proclaimed by the Lieutenant-Governor-in-Council. In view of recent developments it is believed that the provincial government will not urge that the latter action be taken.

Minimum Wage Rates For Skilled Labor Reduced by NRA

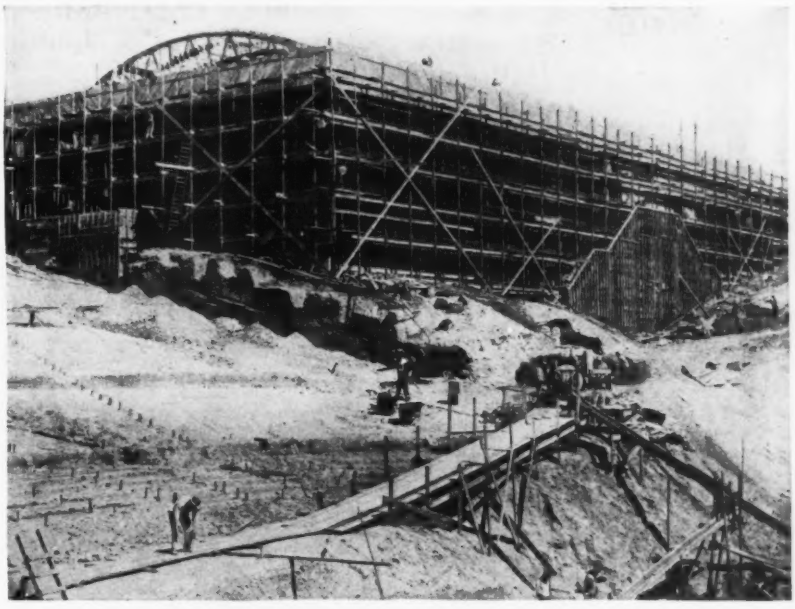
AUTOMATIC stays granted to members of the construction industry against the minimum skilled and unskilled labor rates established in the plumbing and heating and piping chapters of the construction code have been rescinded by an administration order issued by the NRA on April 4. The same order grants exemption for six months to such employers provided they keep certain records and pay not less than certain stated rates, which are less than chapter provisions for skilled labor. These employers are all located within the Northern zone, wherein the skilled labor rate is fixed by chapter provisions at $1.20 per hour. Under the exemption order members of the two divisions in portions of Worcester, Middlesex and Franklin counties, Massachusetts, may pay not less than $1 per hour; members of the plumbing division in Maine may pay not less than $1 per hour in Augusta, Auburn, Lewiston, Bath, Rockland and Bangor, nor less than 90c. per hour in the rest of the state except in the cities and trade areas of Portland and Bar Harbor, where regular code rates of $1.20 per hour remain.

This follows previous action taken on Nov. 20, 1934, exempting members of the plumbing division in Berkeley County, West Virginia, from the rate of $1.10, provided not less than 90c. per hour was paid. On Dec. 3, 1934, members of the same division in Franklin County and that portion of Cumberland County lying outside the Harrisburg metropolitan district in Pennsylvania were similarly exempted from the $1.20 rate provided not less than 90c. per hour was paid for skilled labor. Application for exemptions in other areas have been filed and are pending determination. Meanwhile an area agreement has been advertised for hearing to cover Chester County, Pennsylvania, which encircles the Philadelphia suburban district, and proposes a wage rate of 65c. per hour.

The recommendation by the Construction Code Authority at its meeting on Jan. 25 for exemption until June 16, 1935, of contractors in twelve Southern states from the 40c. minimum unskilled wage rate, provided 30c. an hour is paid and the reduced rate is not used as a minimum basis for skilled labor, has produced no tangible action, and it appears that this matter must go over for consideration under the extension of the codes. It is understood that the exemption does not meet with the approval of the several advisory boards.

Use of Welding for Building To Be Outlined at Conference

New processes and applications of welding will be demonstrated by the University of Wisconsin department of mechanical engineering at a welding conference May 2-3 for engineers, designers, and operators. Programs and exhibits are planned for engineers and contractors. Attention will be given to all-welded buildings for farms, and to studies of flame hardening effect on malleable iron and to the welding of aluminum.



BUILDING CONSTRUCTION RUSHED FOR SAN DIEGO EXPOSITION

Day and night shifts of workmen rush to completion the Palace of Travel, Transportation and Water Power, at the California Pacific International Exposition, San Diego. Sixteen buildings have already been erected; others are to be completed for the opening, May 29. The Ford Building will be in the foreground.

Brief News

A MUNICIPAL BOARD has been set up by the province of Ontario to pass upon all capital expenditures by municipalities within the province. This action has been taken by the provincial legislature to check reckless spending and the issuing of bonds having excessively long terms.

TRENDS IN THE USE OF CLAY PRODUCTS for building construction will be one of the chief topics of the third annual Mineral Industries Conference of Illinois to be held at Urbana, May 17-18. Reinforced brick construction, developments of the rock wool industry, and the use of flotation and concentrating tables for improving crushed stone, sand and gravel are included in the discussions at the conference.

INSTEAD OF BEING TROUBLED with floods and high water levels, Montreal and the surrounding district, especially the St. Lawrence River, is featured this spring by abnormally low water. The opening water level in Montreal harbor is the lowest on record for the last 75 years, and the prevailing maximum draft for the river canal system is 13 ft. 3 in., which is just about the lowest figure on record.

THE CAIRO BRIDGE COMMISSION has been advised that President Roosevelt has signed a bill granting a year's extension of the time in which construction must be started on the $2,500,000 reinforced concrete and steel bridge across the Ohio River at Cairo. The commission has applied to the PWA for a $2,005,000 grant and loan. The preliminary plans for the bridge call for a cantilever bridge to include two 360 ft., two 684 ft., and one 720 ft. spans on the main river structure, while the Illinois approach will include several smaller structures.

Water Supply District Proposed For Counties in South Texas

As a means of meeting the legal requirements of the Public Works Administration, preparatory to making an application for a loan to construct a water pipe line from New Braunfels to Corpus Christi, Texas, a distance of nearly two hundred miles, a bill has been introduced in the state legislature creating the New Braunfels-Gulf Water Supply District. The proposed district will include the counties of Comal, Guadalupe, Wilson, Karnes, Bee, San Patricio and Neuces. The amount of the loan to be sought has not been definitely determined but it will approach $50,000,000. The pipe line is to supply a number of towns in the district with fresh water.

Settlement of San Gabriel Dam Compensated by Rock Fill

According to C. H. Howell, chief engineer of the Los Angeles, Calif., County Flood Control District, the Macco Construction Co. has completed its contract for the placing of rock on the crest and slopes of San Gabriel Dam No. 2. About 63,000 cu.yd. of rock were placed to compensate for the settlement in the structure which started after the flood of Jan. 1, 1934.

Construction of the temporary wooden facing for the dam is still under way by the Case Construction Co., which has the contract for this phase of the work. When the wooden face is completed, the temporary repairs will have been completed and the dam will be allowed to stand for two or three more years to make sure that all settlement has ceased before a permanent new concrete facing is constructed.

Work Started on Housing Project With Mortgage Insured by FHA

The first private government-insured low-cost housing project got under way April 23 at the Colonial Village, Clarendon, Va., a few miles from Washington. Under Sec. 207 of the National Housing Act the mortgage for the cost of construction is insured by the Federal Housing Administration.

The total cost of the Colonial Village project is estimated at $1,128,000 and the insured mortgage is for $875,000. Plans call for six groups of two-story brick apartments, 45 buildings in all, containing 276 units of three to five rooms. Rentals will range from $37.50 to $62.50 a month.

While this is the first of many low cost or limited dividend housing projects to start work under an insured mortgage, tentative commitments to insure six projects for a total of $9,283,000 have been made by the Federal Housing Administration.

Cape Cod Canal Mooring Gets Winooski River Funds

PWA funds amounting to $300,000 for financing the dredging and construction of a mooring place at the entrance of the Cape Cod canal will be transferred from the Winooski River flood control project in Vermont. The transfer is to be made at the request of the War Department to the PWA. The original allotment for the Winooski project was $1,550,000 and was to be used if the Civilian Conservation Corps was discontinued. In view of the anticipated extension of the CCC the War Department asked for the transfer of $300,000 to provide a shelter for ships unable to enter the canal during storms.

Canadian Government to Spend $30,000,000 on Public Works

The Canadian government contemplates an expenditure of $30,000,000 in public works and other forms of unemployment relief during the coming year, this sum being covered by a bill introduced on April 15 by the Minister of Public Works. The government will guarantee loans of eight and seven million dollars respectively to the Canadian National and the Canadian Pacific railways for the repair and purchase of new rolling stock, and they will pay the interest on these for two years.

A sum of $18,000,000 is scheduled for construction, major items including one million to be added to the federal grade separation fund, one and one quarter million for development work in Quebec Harbor (mostly deepening available water), one million for a tunnel between the mainland and Toronto Island in Toronto Harbor, and three and one-half million for special work in the Harbor of Montreal.

In the discussion on this bill, the Minister of Public Works announced that, of the $40,000,000 covered by the 1934 special public works program, only $10,000,000 had so far been spent, but that it was expected that the remaining $30,000,000 would be spent in the current year. This is due to the fact that the large public buildings included in the program are only coming to the active construction stage this spring.

SOCIETY CALENDAR

NATIONAL RIVERS AND HARBORS CONGRESS, annual convention, Washington, D. C., May 2 and 3.

AMERICAN WATER WORKS ASSOCIATION, annual convention, Cincinnati, Ohio, May 6-10.

AMERICAN INSTITUTE OF ARCHITECTS, annual convention, Milwaukee, Wis., May 28-30. THE PRODUCERS' COUNCIL will hold its 12th annual meeting in connection with the Institute meeting.

AMERICAN SOCIETY FOR TESTING MATERIALS, annual meeting, Detroit, June 24-28.

AMERICAN SOCIETY OF CIVIL ENGINEERS, annual convention, Los Angeles, July 3-5.

NEW YORK STATE SOCIETY OF PROFESSIONAL ENGINEERS, annual meeting, New York, May 18, 1935.

THE NEW ENGLAND ROAD BUILDERS' ASSOCIATION at a meeting April 16 elected the following officers: President, Louis R. Perini, Wellesley; vice-president, C. Joseph Maney, Cambridge; treasurer, Joseph A. Tomasello, Boston; secretary, Frederick Hoitt; directors, David A. Bridge, Hazardville, Conn.; Carlo Bianchi, Framingham; James A. Knowlton, Belmont; Abner P. Lawton, Providence, R. I.; E. Raymond Newell, Uxbridge; D. W. Overocker, Burlington, Vt.; James F. Powers, Brockton; Ovid F. Winslow, Nashua, N. H.

THE CONFERENCE OF METROPOLITAN STUDENT CHAPTERS, American Society of Civil Engineers, will hold their annual Spring Conference on May 3 in the Engineering Societies Building, 33 West 39th Street, New York City. The student chapters of eight engineering schools are participating in this conference where four student papers will be read in competition for two prize awards.

THE PHILADELPHIA SECTION, American Society of Civil Engineers, had their first annual student convention at Swarthmore College on April 17, 1935. Over 100 students from the various eastern colleges having Student Chapters were present. A prize award of $20 was made for the best presentation of the best paper. Award was made to H. F. Redmile, University of Delaware, who read a paper on "Tests of Concrete Slabs Reinforced with Wire Mesh."

THE ARKANSAS-OKLAHOMA SECTION, Society for the Promotion of Engineering Education, meeting at the University of Arkansas, Fayetteville, named Prof. C. L. Farrer of the University of Oklahoma as President. Other officers are Prof. C. R. Wood, Oklahoma A. & M., first vice-president; Prof. A. S. Brown, University of Arkansas, second vice-president; Prof. L. A. Comp, University of Oklahoma, secretary-treasurer.

Personals

JAMES ARTHUR REED, formerly engineer of the third district of the Kentucky State Highway Commission, has been appointed a member of the State Highway Commission. This fact was not brought out in the personal note concerning Mr. Reed, published in our issue of April 18, due to an error in typesetting.

B. F. MORRIS, former president of the Pioneer Sand & Gravel Co. and later with George Scofield & Co., has been named general manager of Galbraith & Co., Seattle building material concern.

E. AGUERREVERE, formerly an engineer with the Cities Service Co., New York, and his brothers P. I. and S. E. AGUERREVERE, have opened an office as consultants in civil engineering, geophysics and geology in Caracas, Venezuela. All three are graduates of Stanford University.

P. H. CARLIN has assumed the editorship of *Civil Engineering*, published by the American Society of Civil Engineers. Mr. Carlin graduated from the University of Pennsylvania in 1922, and from 1924 to 1932 he was with the Philadelphia department of city transit engaged in the design of subways. Since 1931 he has been editor of the Philadelphia Section's monthly publication.

F. A. MARYE has been appointed to succeed Perry A. Rowe as director of the work division of the Kentucky Emergency Relief Administration. Mr. Marye, a graduate of Virginia Polytechnic Institute in 1922, has been engaged in civil engineering and construction work for several years. Prior to his appointment he was assistant to Director Rowe.

EDWARD L. MORELAND, Wellesley, Mass., senior partner in the Boston engineering firm of Jackson & Moreland, has been appointed head of the electrical engineering department of the Massachusetts Institute of Technology. Mr. Moreland is chairman of the Wellesley Water and Municipal Light Commission and the Sewer Commissioners. He is a graduate of Johns Hopkins University and Massachusetts Institute of Technology.

PAUL A. SMITH, Defiance, Ohio, has been appointed engineer for division No. 1 of the state highway department.

LESTER M. HOLT, supervising engineer of the Indian Irrigation Service, retired April 15, after 39 years in government service. In 1902 Mr. Holt received his degree of civil engineer from George Washington University. Since 1910 he has been engaged in various projects in the Indian Irrigation Service.

COL. WILDUR WILLING, commanding officer of the Second Engineers, Fort Logan, Colo., is soon to be transferred to the office of the Chief of Engineers, Washington, D. C.

W. E. BRACKETT, former resident engineer of the Maine State Highway Commission, has recently been appointed town manager of Oakland, Maine. He was at one time executive director of the Maine state planning board, and for three years was town manager of Washburn, Maine.

C. B. NOLTE has resigned his position as president of the Robert W. Hunt Co., consulting engineers, Chicago, to become president of the Crane Co. JAMES C. OGDEN, formerly vice-president of the Hunt company, will succeed Mr. Nolte as president and will be assisted by F. M. RANDLETT.

LEE H. HUNTLEY, construction superintendent under the TVA at the Joe Wheeler Dam, has been appointed to a similar position at the Pickwick Landing dam.

GEORGE P. JESSUP, formerly in charge of a PWA project on Long Island, has been appointed to succeed Lee H. Huntley as construction superintendent at the Joe Wheeler Dam.

H. A. PARKER, construction engineer for the Federal reclamation bureau, will take charge of the completion of the reservoir program on the north fork of the Snake River in Idaho.

GEORGE P. DIEMER, Rochester, N. Y., architect, has been appointed a supervising architect for the Federal Housing Administration in the Rochester district. Mr. Diemer formerly was associated with Gordon and Kaelber. He supervised the building of the Men's College, Rochester University and other large projects in Rochester and New York.

Obituary

HENRY BORNHAUSER, for many years a building contractor in Louisville, Ky., died there on March 25 at the age of 80. Mr. Bornhauser retired from the firm of Henry Bornhauser Co. eight years ago.

PATRICK J. FLANAGAN, for many years a prominent contractor at Boston, Mass., died at his home in Dorchester on April 16. He was born in Ireland 66 years ago and was in charge of the erection of many important buildings in Boston.

WILLIAM TIMMERMAN, construction engineer, of Richmond Hill, L. I., N. Y., died recently in Washington, D. C. He had been ill since returning from Tokyo, Japan, where he supervised the construction of the St. Luke's Medical Center. He was a graduate of Brooklyn Polytechnic Institute, and for years was associated with Robert D. Kohn and Charles Butler, architects, of New York City.

NELSON W. BENEDICT, Norwalk, Conn., district superintendent of the State Highway Department, died April 16 at the Norwalk Hospital. Mr. Benedict was 66 years old and had been superintendent of the state highway district at Norwalk since 1924.

JAMES A. CHILDS, sanitary engineer, Minneapolis-St. Paul Sanitary District, died in St. Paul, Minn., on April 13 following a long illness. Born in Fergus Falls, Minn., in 1886 he was graduated in civil engineering in 1909 from the University of Minnesota and for the next 18 years was connected with the Minnesota Department of Health as sanitary engineer. In 1927 he became chief engineer and secretary of the Metropolitan Drainage Commission, the forerunner of the Minneapolis-St. Paul Sanitary District. To him is largely to be credited the adoption of a program of sewage-treatment plant construction by the Twin Cities.

EDWIN PHILLIPS BACON, 62, an architect in Buffalo, N. Y. for 40 years, died April 9. Mr. Bacon was a member of the firm of Bacon and Lurkey. He served 9 years as superintendent of construction for the U. S. Treasury department. He designed the Medical Arts Center building in Buffalo, the Mayflower apartment and many theatres.

CONSTRUCTION STATISTICS OF THE WEEK

ENGINEERING construction awards at $20,677,000 are lower for the week, due to low public works awards and to private construction below the record volume of recent weeks. Private awards for the week continue higher than a year ago. At $7,385,000 private volume is 37 per cent above the average for 1934. Public awards at $13,292,000 are considerably below the average, the loss being in state and municipal work for which only $10,384,000 went under contract this week. The federal volume of $2,908,000 is a slight increase over last week.

Highway awards staged a comeback, totalling $5,184,000 for the week. Industrial building awards at $4,555,000 also are heavier than last week. Bridges at $849,000 while below average were ahead of the low total a week ago. Earthwork, irrigation and drainage is slightly higher, $1,417,000. Other classes of work are below a week ago. Commercial buildings total $1,352,000 for the week, public buildings, $4,225,000; waterworks, $544,000, sewerage, $1,006,000.

The larger awards include: Steel mill, at Anderson, Ind., for Greer Steel Co., Dover, O., $1,000,000; plant for Continental Can Co., Elwood, Ind., $500,000; ward and surgical buildings at city hospital, Worcester, Mass., $617,000; streets and roads by Georgia, $520,000 and bituminous road materials by Virginia State Highway Department, $811,000. At Indianapolis, contract was let for a building for the sewage disposal plant and for installing machinery for addition to sludge plant, $488,000; and the Minneapolis-St. Paul Sanitary District let Contract 108, Div. B, Job 22, intercepting sewer, for $340,000. The Senecaville dam, Senecaville, Ohio, $329,000, and Moon Lake Dam near Duchesne, Utah, for $547,000 were put under contract by the federal government. In Texas, the Magnolia Petroleum Co., Austin, is reconditioning pipe line, $1,000,000.

New capital includes $4,858,000 in state and municipal bond sales and $8,249,000 in PWA allotments for non-federal work on recently approved projects.

CONTRACTS

(Thousands of Dollars)

	Weekly Apr. 1934	Average Prev. 4 Weeks	Week Apr. 25 1935
Federal Government	$6,389	$4,443	$2,908
State and municipal	15,432	14,357	10,383
Total public	$21,821	$18,800	$13,291
Total private	4,781	9,919	7,385
Week's total	$26,602	$28,719	$20,676
Cumulative to date:			
1934	$486,238,000	1935	$424,283,000

NEW PRODUCTIVE CAPITAL

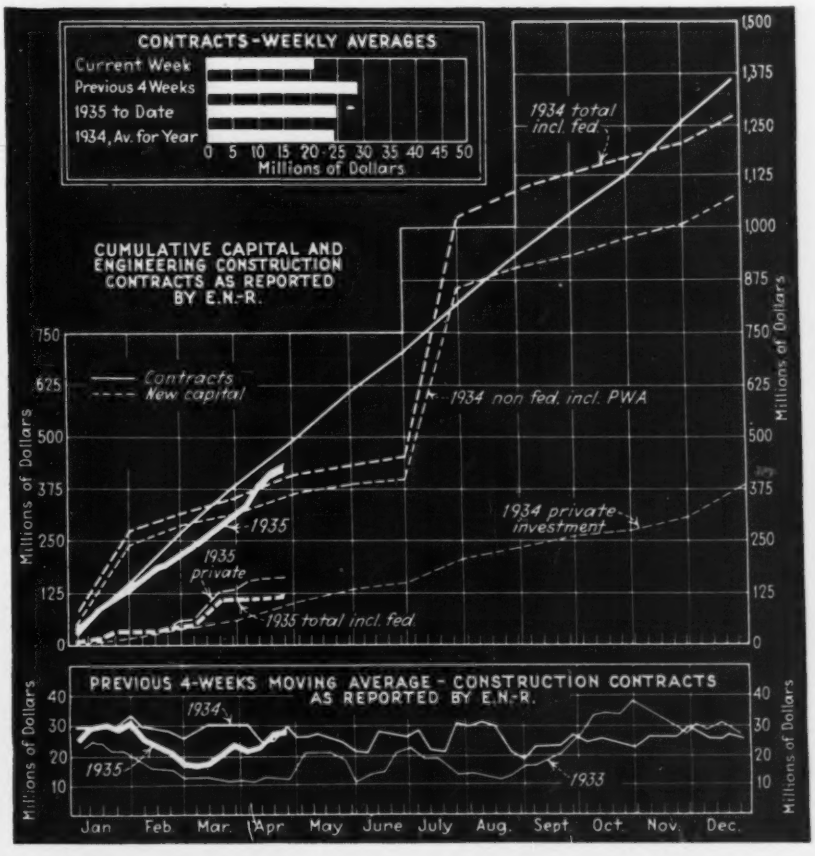
(Thousands of Dollars)

1935	Week Apr. 25	Cumulative
State and municipal	$4,858	$139,101
PWA allotments, S&M	+8,249	—38,426
RFC loans, S&M	....	84
Corporate issues	....	....
PWA allotments, private	....	8,129
Total, Non-Federal	$13,107	$108,888
PWA allotments, Federal Constr.	.....	7,336
Total new capital	$13,107	$116,224
Cumulative to date:		
1934	$403,964,000	1935	$116,224,000

Note: These figures include private bonds, and stocks sold for productive purposes; state and municipal bonds for construction; PWA loans and grants to states and municipalities, including the special highway funds; PWA private loans, and allotments for Federal construction. Negative amounts in PWA totals indicate excess of rescissions and reductions over reallotments and increases in outstanding allotments.

INDEX NUMBER

E.N.R.-Cost	1913 = 100	1926 = 100	E.N.R.-Volume	1913 = 100	1926 = 100
Apr., 1935	194.50	93.49	Mar., 1935	101	44
Mar., 1935	194.26	93.38	Feb., 1935	76	33
Apr., 1934	195.86	93.90	Mar., 1934	116	51
1934 (Av.)	198.10	95.23	1934 (Av.)	114	50
1933 (Av.)	170.18	81.80	1933 (Av.)	102	47
1932 (Av.)	156.97	75.45	1932 (Av.)	127	56

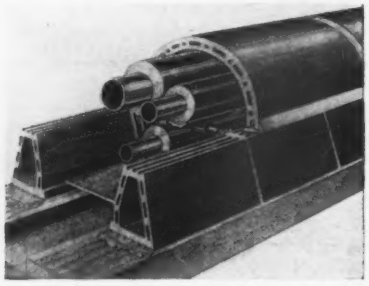


Construction Equipment and Materials

Arch Tile Conduit For Underground Steam Lines

In an endeavor to effect economy and accessibility in underground steam conduits, a new construction system called Therm-O-Tile has been developed by H. W. Porter & Co., Inc., Newark, N. J.

This system is characterized by a continuous concrete base with a built-in drain. The pipes are supported directly from the base on adjustable iron supports, taking strain from the joints of the conduit walls



Therm-O-Tile conduit assembly

while lines are expanding and contracting in service. The conduit envelope is made up of trapezoidal tile base sections and a top arch of tile. Various sizes of tile sections allow for the making up of conduits of varying sizes and capacity. The absence of bell joints permits the application of continuous waterproofing. Access to the pipe at any point in the conduit is also facilitated by this smooth joint construction.

Three-Cylinder Air Compressor Works at Lower Temperature

To economize on power through the lowering of air temperature a new line of three-cylinder air compressors has been developed by the Gardner-Denver Co., Quincy, Ill. This lower air temperature is achieved by the use of two small low-pressure cylinders instead of one large one. The two-stage construction with its water-cooled cylinders and intercooler assures lower wall temperature and longer life of the machinery. This new compressor, available in sizes from 113 to 194 cu.ft. per minute displacement, may be run in either direction. For efficient lubrication it has a force feed pressure system.

Heavy-Duty Power Screen

The Smith Engineering Works, Milwaukee, Wis., has recently developed a new heavy duty Pulsator, designed to screen sand, gravel, crushed rock, ore or coal. An eccentric action produces a circular movement which the manufacturer claims produces a maximum screening action which is uniform over the entire screening area.

The frame is horizontal and compact and rigid. The shaft is journaled in a self-contained unit and is mounted on the frame. The vibrator unit may be readily removed and taken apart in the field for repairs.

The new Telsmith Pulsator is made in 8 sizes from 2x6 ft. to 4x12 ft., with single, double and triple deck.

Helical Gear Reduction Unit Allows Choice of Motors

Realizing the user's preference for various makes of electric motors the Ajax Flexible Coupling Co., Westfield, N. Y., has produced a helical gear reduction unit called the Lectrigear, made in sizes ranging from ½ to 2 hp. Standard footless motors are used without change in shaft or bearings.

The Lectrigear is furnished either with or without motors, so that the user if he desires may employ any one of several standard makes.

New Equipment in Brief

Trap Rock Crusher. The Traylor Engineering and Mfg. Co., Allentown, Pa., has designed a small crusher for use in the small plant. This new TY crusher has all the efficiency features of the larger Traylor crushers. It comes in two sizes; one with a nominal feed opening of 3 in., and the other with a feed opening of 4½ in. The screen perforations range from 1½ in. to ¼ in.

Arc Welder. For increased use of light-gauge metal, the Hobart Co., Troy, Ohio, has brought out a new arc welder. Rated at 75 amp. 25 volts, it has a welding range of 15 to 125 amp. in three steps. The new welder uses 1/16, 3/32, or ⅛ in. electrodes, bare or coated. It is available in either the stationary or portable type.

New Portable Mixer. The Koehring Co., Milwaukee, Wis., has introduced a new portable concrete mixer, the 14-S. It is light enough to be towed on two wheels, as it weighs but 5,100 lb., and is only 90 in. wide. Automatic water tank and self-leveling skip are included. The charging skip is free from obstructions at the front and sides, permitting fast and easy charging.

Vibratory Dry Feeder. A vibrating feeder for providing a continuous and controlled flow of dry materials is being marketed by the Syntron Co., Pittsburgh, Pa. This new dry feeder may be used for feeding chemicals in treating water or for feeding materials into continuous mixes. A vibrating hopper and a vibrating feed trough are controlled by a rheostat to discharge from 2 oz. to 2,000 lb. per hour.

Excavator. A full-revolving ⅜-yd. excavator, known as Model 11, Bantam Weight, has been announced by the Harnischfeger Corp., Milwaukee, Wis. The machine weighs about 15,800 lb. It has a travel speed of from 1½ to 3 miles per hour. The design of the cab permits visibility through an angle of 210 degrees. The machine is powered by a Ford V-8 truck-motor, delivering 40 hp. at 1300 r.p.m.

Business Notes

THE ARMSTRONG CORK CO., Lancaster, Pa., announces that a building material division to handle the sales of its insulating products has been organized. The new division, managed by H. R. Peck, consolidates six former sales divisions of the company.

RIEHLE BROS. TESTING MACHINE CO., Philadelphia, Pa., has become a part of American Machine and Metals, Inc. Abbott F. Riehle will continue as general manager at the new executive office, 100 Sixth Ave., New York, N. Y. The engineering staff has been transferred from Philadelphia to the American Machine and Metals plant in East Moline, Ill.

THE INTERNATIONAL NON-STAINING CEMENT CO., INC., Brooklyn, N. Y., has been appointed sales representative for Metropolitan New York by the Southern Cement Co.

New Publications

METALLIC ZINC POWDER IN INDUSTRIAL PAINTS, The New Jersey Zinc Company. 6x9, 16 pages.

KAWNEER RUSTLESS METAL DOORS, The Kawneer Company, Niles, Michigan. 8½x11, 8 pages.

THE NOEL SPEED ARC WELDER, The Ideal Electric & Manufacturing Co., Mansfield, Ohio. 8½x11, 16 pages. Bulletin 910.

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